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Downward Nominal Wage Rigidity and the Case for Temporary Inflation in the Eurozone

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Since 2008, the periphery of Europe has been suffering an economic contraction of a magnitude that in several countries is comparable to the US Great Depression. During the early 2000s, the periphery of Europe enjoyed rapid growth in domestic demand, wages, and employment. Much of this bonanza was fueled by large international capital inflows. Figure 1 displays the current account, nominal hourly wages, and the rate of unemployment in five peripheral eurozone countries between 2000 and 2011. In all five countries, current accounts sharply deteriorated between 2000 and 2008. During this period, some countries increased their external debt position by more than 50 percent of GDP. This large amount of external borrowing financed a boom in domestic demand and was accompanied by increases in nominal wages of about 50 percent.

With the arrival of the international financial crisis of 2008, external credit to peripheral Europe suddenly dried up, causing a sharp contraction in aggregate demand. However, nominal hourly wages, shown in the second column of Figure 1, far from falling, remained largely unchanged from the high levels they had reached during the boom years. The combination of weak aggregate demand and high labor costs was associated with widespread unemployment, shown in the third column of Figure 1.

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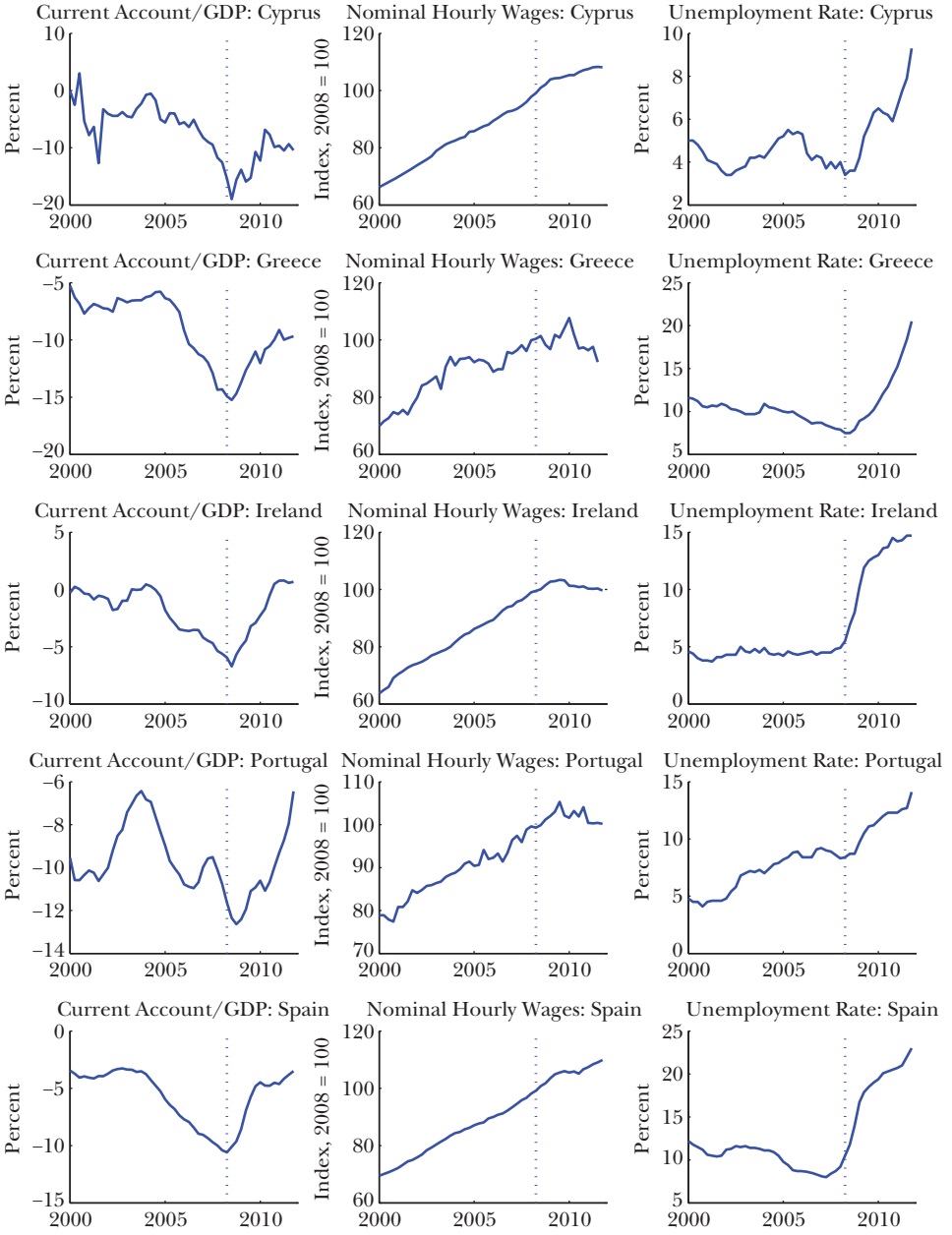
Figure 1
Boom–Bust Cycle, Downward Wage Rigidity, and Unemployment in the Eurozone



Source: Eurostat.

The observed failure of nominal wages to adjust downward after 2008 despite sizable increases in unemployment suggests that downward nominal wage rigidity played an important role in the current unemployment crisis in the euro area. In Schmitt-Grohé and Uribe (2010, 2011a, 2011b, 2012), we develop a dynamic stochastic general equilibrium model of a small open economy with tradable and nontradable goods, downward nominal wage rigidity, and a fixed nominal exchange rate that captures these dynamics. The fundamental intuition behind that model is as follows. Suppose a member of the euro area suffers a negative external shock, such as an increase in the country risk premium, which causes aggregate demand to decline. The efficient adjustment to an external shock of this type is a decline in real wages. However, downward nominal wage rigidity and a fixed exchange rate together imply that real wages measured in terms of tradable goods are downwardly rigid. As a result, the labor market fails to clear and involuntary unemployment emerges. This narrative is well-known and goes back at least to Keynes (1925) and Friedman (1953).

If downward nominal wage rigidity is persistent, the current crisis in Europe is likely to be a protracted one, unless policymakers intervene. The affected eurozone countries, however, find themselves with limited room for national monetary and fiscal policy action. For instance, devaluation of the domestic currency would foster employment by reducing firms' real labor costs. But breaking away from the European monetary union is, at least thus far, off the table. Expansionary domestic fiscal policies, such as labor or sales subsidies, could be effective in remedying the distortions in the labor market. However, this policy option also faces obstacles insofar as expansionary fiscal policy is discouraged by international institutions, which make fiscal austerity a precondition for financial assistance. It is conceivable therefore that putting the periphery of Europe back on the path to recovery might at least in part require the involvement of supranational European institutions. The fact that the eurozone is a monetary but not a fiscal union rules out Europe-wide fiscal policy interventions.

In this article, we argue that a natural and practical remedy to the problems of the eurozone is monetary in nature. Specifically, a one-time rise in the overall price level in the euro area, a temporary period of inflation, would go a long way toward restoring full employment in the periphery of Europe. This monetary policy should be geared toward deflating the real value of wages in the periphery countries back to their pre-boom levels. We estimate that this policy could be implemented by raising the euro area annual rate of inflation to about 4 percent for the next five years.

However, this line of argument does not also hold that inflation should be higher in the long run. In fact, loose monetary policy should cease as soon as employment returns to normal levels. As such, our arguments here are not inconsistent with the long-run inflation target of the European Central Bank of slightly below 2 percent per annum. Therefore our argument is also different from that presented in related work suggesting that current inflation targets in developed countries are too low and should be permanently raised to deal with crises (Summers 1991; Blanchard, DellAriccia, and Mauro 2010).

Involuntary Unemployment Due to Wage Rigidity

The large capital inflows experienced by countries in the periphery of the eurozone during the boom years of 2000 to 2008 lead to sizeable increases in nominal hourly wages and the relative price of nontradables in terms of tradables. To capture these price dynamics, we adopt a framework in which the economy produces and consumes traded and nontraded goods. In this framework, large capital inflows raise the demand for nontraded goods. The supply of nontraded goods is relatively more inelastic than the supply of traded goods because nontraded goods cannot be imported and must be produced domestically. To satisfy the increased demand, producers of nontradables will increase production, given cost, only if the relative price of nontradables increases. Thus a model with traded and nontraded goods has the potential to explain why the relative price of nontradables appreciates when a country experiences large capital inflows.

The adjustment friction that motivates the policy interventions we suggest in this article is downward rigidity in nominal wages. Specifically, we model downward nominal wage rigidity as a lower bound on the growth rate of nominal wages such that nominal wages in a given time period do not decline, and might rise, from the previous period. We embed the assumption of downward nominal wage rigidity into a small open economy with a tradable and a nontradable sector. For a formal derivation of the underlying theoretical framework see Schmitt-Grohé and Uribe (2010). Here we focus on a graphical representation.

There is extensive empirical evidence on downward nominal wage rigidity. One branch of the empirical literature studies asymmetries in the distribution of observed hourly wage changes of individual workers. This literature documents that far more workers receive a wage increase than a wage cut. Importantly, almost half of all workers experience no changes in their hourly compensations. For examples, see Fortin (1996), Kuroda and Yamamoto (2003), Fehr and Goette (2005), Gottschalk (2005), Dickens et al. (2007), Barattieri, Basu, and Gottschalk (2012), Kaur (2012), and Daly, Hobijn, and Lucking (2012).

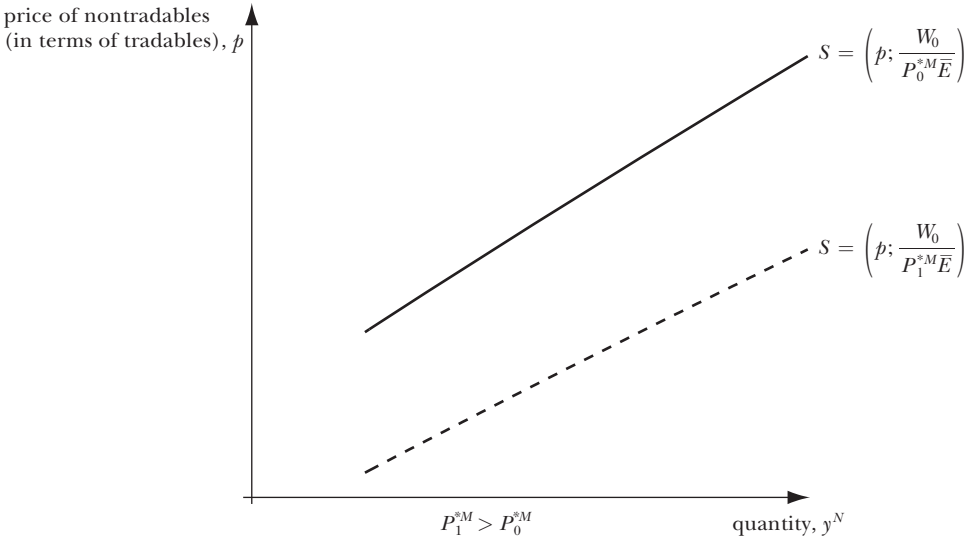
A second branch of the empirical literature provides evidence for downward nominal wage rigidity using aggregate data. For example, Holden and Wulfsberg (2008) document downward nominal wage rigidity using data for hourly nominal wages at the industry level in 19 OECD countries over the period 1973 to 1999. In Schmitt-Grohé and Uribe (2010), we provide empirical evidence for a number of emerging countries, including those in the periphery of Europe.

Figure 1 also suggests that nominal wages are downwardly rigid. Specifically, it shows that since the onset of the Great Recession in 2008Q2, even though unemployment rose sharply in the periphery of Europe, nominal wages in Cyprus, Ireland, Portugal, and Spain did not decline.

The Supply of Nontradables

Consider the supply schedule of nontradables, which is shown with a solid upward sloping line in Figure 2. The horizontal axis measures the quantity of

Figure 2
The Supply Schedule for Nontradables



Notes: On the *y*-axis, p is the relative price of nontradables in terms of tradables. On the *x*-axis, y^N is the quantity of nontradables produced. P_t^M is the nominal price of traded goods. W_t is the nominal wage rate. W_t/P_t^M is the real wage in terms of tradables. P_t^{*M} is the foreign currency price of traded goods. $P_t^M = P_t^{*M} E_t$, where E is the exchange rate.

nontradables produced, y^N. The vertical axis measures the relative price of nontradables in terms of tradables (or the real exchange rate), denoted p. The supply schedule is upward sloping because an increase in the relative price of nontradables induces firms to supply more nontraded goods.

The location of the supply schedule depends on the cost of production. If costs of production decrease, the supply schedule shifts down and to the right. This is because at lower costs, profit-maximizing firms are willing to supply more goods at the same price. Costs of production depend on labor cost, and labor costs in turn depend on the wage rate. The wage rate relevant for the supply schedule drawn in the space (y^N, p) are wages in terms of traded goods. Let P_t^M denote the nominal price of traded goods. Then the location of the supply schedule will depend on the real wage in terms of tradables, or W_t/P_t^M, where W_t denotes the nominal wage rate in period t.

We assume that the law of one price holds for traded goods. This means that the price of traded goods is the same in the home country and the foreign country when expressed in a common currency. Formally, when the law of one price holds, the domestic currency price of traded goods must satisfy $P_t^M = P_t^{*M} E_t$, where P_t^{*M} denotes the foreign-currency price of traded goods and E_t denotes the nominal exchange rate defined as the domestic-currency price of one unit of foreign currency. Throughout our analysis, we will assume that the exchange rate is credibly

and permanently fixed at $\bar{E}$, that is, $E_t = \bar{E}$ for all periods $t \geq 0$. This assumption captures the situation of a country in the periphery of the eurozone for whom breaking away from the euro is not an option.

To reflect the dependence of the supply schedule on labor costs, we express it as $y^N = S(p; W/(P^{*M}\bar{E}))$.[1] Holding constant the nominal wage, W, and the nominal exchange rate, $\bar{E}$, an increase in the international price of tradable goods, P^{*M}, lowers labor costs by lowering real wages in terms of traded goods. Graphically, an increase in the foreign price level from P_0^{*M} to $P_1^{*M} > P_0^{*M}$ results in a shift in the supply schedule down and to the right. This shift is shown with a dashed line in Figure 2. An increase in the foreign price level, holding constant nominal wages, lowers the real labor cost faced by domestic firms and provides an incentive for increased production. This is the key economic mechanism through which foreign inflation can have an expansionary effect in economies with downwardly rigid nominal wages and a fixed exchange rate.

The Demand for Nontradables

Nontraded goods are goods that are domestically produced and cannot be easily or cheaply shipped abroad. Therefore, the law of one price does not hold for nontraded goods. An example of a nontraded good is housing, and hence the construction sector is a sector that produces nontraded goods.

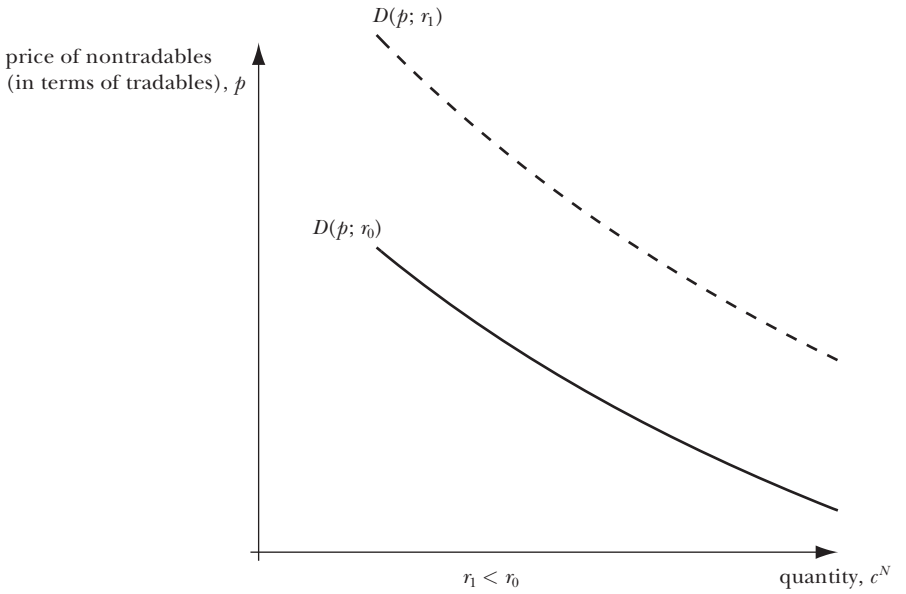
We denote the aggregate demand function for nontradables by $c_t^N = D(p_t; r_t, tot_t, \ldots)$, where c_t^N denotes consumption of nontradables, r_t denotes the country interest rate, and tot_t denotes the terms of trade.[2] The demand function is decreasing in the relative price of nontradables, p_t, because, all other things equal, as nontradables become relatively more expensive, households substitute tradables for nontradables in their consumption basket.

The shifters of the demand schedule are variables that affect either the intertemporal price of consumption, or households' wealth, or both. Among the variables that affect both the intertemporal price of consumption and wealth is the real interest rate

[1] The supply schedule can be derived as follows. Assume that the production function is $y^N = F(h)$, where h denotes hours, and $F(.)$ is an increasing and concave production function. Profits of firms are given by $P^N y^N - Wh$, where P^N is the nominal price of nontraded goods. Firms take prices and wages as given. Profits are maximized when the value of the marginal product of labor equals marginal costs, that is, when $P_t^N F'(h_t) = W_t$. Suppose the production function is of the form $F(h) = h^\alpha$, where $\alpha \in (0, 1)$ is a positive coefficient. Then the supply schedule takes the form $S(p; W/(P^{*M}\bar{E})) = (\alpha p/(W/(P^{*M}\bar{E}))^{\alpha/1-\alpha}$.

[2] Formally, one can derive the demand for nontradables as follows. Suppose households have preferences over an aggregate consumption good c_t composed of traded and nontraded consumption, c_t^T and c_t^N, respectively. Assume further that the technology for aggregating tradable and nontradable consumption goods into a composite consumption good (denoted c) is of the constant elasticity of substitution (CES) form $c = [a(c^T)^{1-1/\xi} + (1-a)(c^N)^{1-1/\xi}]^{1/(1-1/\xi)}$, where $a \in (0, 1)$ denotes the share of traded goods in total consumption, and ξ denotes the intratemporal elasticity of substitution between traded and nontraded goods. Utility-maximizing households choose consumption of traded and nontraded goods so as to make the marginal rate of substitution between traded and nontraded goods, which is given by $(1-a)/a(c^T/c^N)^{1/\xi}$, equal to the relative price, p. This implies that $c^N = c^T((1-a)/(ap))^\xi$. Consumption of traded goods c^T, in turn, is a function of the interest rate, r_t, the terms of trade, tot_t, and other measures of household wealth.

Figure 3
The Demand Schedule for Nontradables



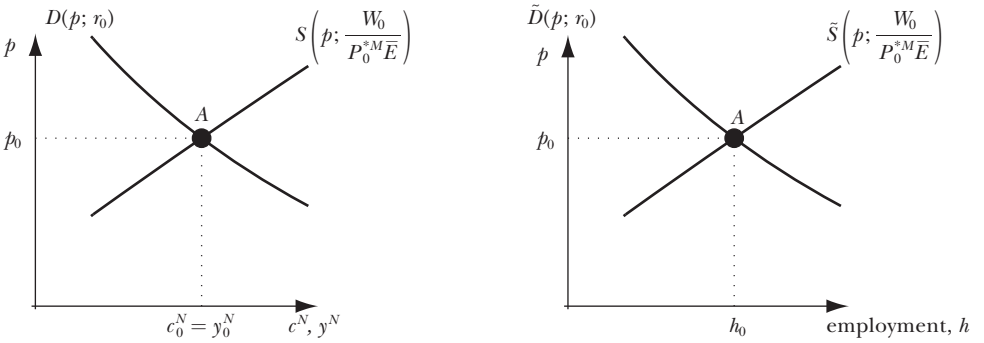
Notes: On the *y*-axis, p is relative price of nontradables in terms of tradables. On the *x*-axis, c^N is the consumption of nontradables. Demand for nontradables is a function of p, and the country interest rate, r.

that the rest of the world charges the country for borrowing in international bond markets. Country interest rate shocks have been shown to be an important driver of business cycles in emerging economies (Neumeyer and Perri 2005; Uribe and Yue 2006). Assuming that the country is a net debtor to the rest of the world, which is the case of empirical interest in the application considered here, an increase in the country interest rate r_t causes a negative wealth effect and a negative intertemporal substitution effect. Both of these effects tend to depress the demand for nontraded goods, shifting the demand schedule down and to the left.

Figure 3 displays the demand for nontradables in the space (c_t^N, p_t) for two values of the interest rate. The solid line shows the demand schedule for a high value of the interest rate, r_0, and the dashed line shows the demand schedule for a lower value of the interest rate $r_1 < r_0$. A decrease in the interest rate, from r_0 to r_1, would shift the demand schedule up and to the right. Conversely, an increase in the interest rate from r_1 back to the level of r_0 (the situation we were discussing above), shifts the demand schedule down and to the left (from the dashed line to the solid line).

Another shifter of the demand schedule is the terms of trade, denoted tot_t, and defined as the relative price of exportable goods, P_t^{*X}, in terms of importable goods,

Figure 4
Equilibrium in the Nontraded Goods Market and the Demand for Labor



Notes: p is relative price of nontradables in terms of tradables, c^N is the consumption of nontradables, y is the quantity of nontradables, and r is the country interest rate. W is the nominal wage rate, P^{*M} is the foreign currency price of traded goods, E is the exchange rate, and $W/P^{*M}E$ is the real wage. Output of nontradables is increasing in hours worked, so in the graph on the right along the x-axis, we replace quantity consumed and produced by employment in hours worked, h. Figure 4 represents a partial equilibrium analysis because it takes the nominal wage rate as given.

$tot_t \equiv P_t^{*X}/P_t^{*M}$. An improvement in the terms of trade (that is, an increase in tot_t) has a positive wealth effect that pushes the demand schedule up and to the right (not shown in Figure 3).

Equilibrium in the Nontraded Sector and the Demand for Labor

In equilibrium, the market for nontraded goods must clear. This means that the quantity supplied of nontradables must equal the quantity demanded of nontradables.[3] The left panel of Figure 4 indicates with point A the intersection of the demand schedule with the supply schedule. Given the real wage, $W/(P^{*M}\bar{E})$, and given the country interest rate, r_0, the intersection of the demand and supply schedule determines the value of the relative price of nontradables. At point A, the relative price is equal to p_0 and consumption and production of nontraded goods is equal to $c_0^N = y_0^N$. These values depend of the level of exogenous variables such as the country interest rate, the foreign price level, the exchange rate, and on endogenous variables, such as the nominal wage rate. Figure 4 represents a partial equilibrium analysis because it takes the nominal wage rate, W_0, as given.

The nominal wage rate is an endogenous variable that adjusts, to the extent possible, to clear the labor market. To understand how nominal wages are determined we need to introduce the supply and demand for labor, h, into our graphical

[3] Formally, the equilibrium value of the relative price of nontraded goods must solve $S(p_t; W_t/(P_t^{*M}\bar{E})) = D(p_t; r_t)$.

analysis. We can use the fact that demand and supply of nontraded goods must be equal to each other to derive the demand for labor in the nontraded sector.

Note that nontraded goods are produced with labor so that output of nontradables is increasing in hours worked in the nontraded sector. Thus, we can redraw the left panel of Figure 4 replacing output and consumption of nontradables by hours worked in the nontraded sector. The horizontal axis of the right panel of Figure 4 measures hours worked in the nontraded sector. Because the horizontal axis measures employment rather than output, we change the label of the supply curve from $S(p;\ W_0/(P_0^{*M}\bar{E}))$ to $\tilde{S}(p;\ W_0/(P_0^{*M}\bar{E}))$. Similarly, we change the label of the demand function from $D(p;\ r_0)$ to $\tilde{D}(p;\ r_0)$. The intersection of the demand and supply schedule can now be interpreted as determining the demand for labor given the real wage, $W_0/(P_0^{*M}\bar{E})$.

One can use the right panel of Figure 4 to find the demand for labor for different values of the country interest rate or the real wage. For example, an increase in the country interest rate would shift the demand schedule $\tilde{D}(p;\ r)$ down and to the left, so that the intersection of the demand and supply schedule occurs for a lower value of h. Therefore, an increase in the country interest rate lowers demand for labor in the nontraded sector given wages. Or consider an increase in the foreign price level, P^{*M}. Such an increase lowers the real wage and shifts the supply schedule $\tilde{S}(p;\ W/P^{*M}\bar{E})$ down and to the right. The new intersection of demand and supply would occur at a larger value of h, indicating that an increase in foreign inflation raises the demand for labor in the nontraded sector.

Involuntary Unemployment

We assume that workers supply inelastically $\bar{h}$ hours of work to the market.[4] Suppose that for a given nominal wage, the intersection of the demand and supply for nontradables occurs at a point that requires more labor than workers are willing to supply at that wage. In terms of Figure 4, this would correspond to a case in which $h_0 > \bar{h}$. In that case, we would expect wages to rise. That is, W_0 could not be the equilibrium wage rate. Alternatively, suppose that at point A in Figure 4, the amount of labor needed to produce the equilibrium level of nontradables is less than the amount workers would like to supply at that wage, that is, suppose that $h_0 < \bar{h}$. If wages were fully flexible, this excess supply of labor should result in a decline in the wage rate to a value below W_0. But if wages are downwardly rigid, then the excess supply of labor remains because wages cannot fall. The labor market is in disequilibrium because labor demand falls short of labor supply, and involuntary unemployment emerges.

[4] One can show that our analysis is robust to introducing elastic labor supply or production in the traded sector.

Boom Years Followed by External Crisis

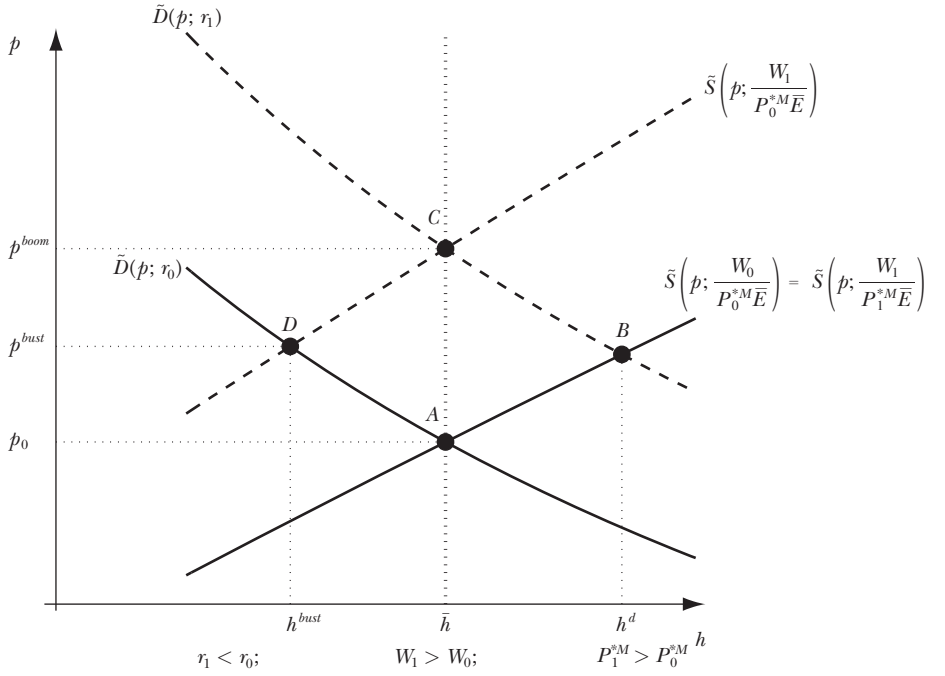
Having introduced the key elements of our framework, we can now use it to interpret the boom–bust episode that afflicted the periphery of Europe over the past decade. Suppose the economy starts at point A in Figure 5. The figure is drawn such that when the international price of tradables equals P_0^{*M}, the country interest rate equals r_0, and the nominal wage equals W_0, the economy enjoys full employment—that is, $h = \bar{h}$, and the equilibrium relative price of nontradables is p_0. Notice that now the figure also shows the labor supply schedule, which, because of our assumption of an inelastic labor supply, is represented by a vertical dashed line. Think of point A in Figure 5 as the location of peripheral Europe in 2000, the year the euro was adopted. With the adoption of the euro, borrowing rates dropped sharply for most peripheral countries. The decline in rates led to large capital inflows.

The decline in interest rates shifts the demand of nontradables up and to the right. Specifically, in Figure 5 we assume that interest rates fall from r_0 to $r_1 < r_0$. The demand schedule associated with r_0 is shown with a downward-sloping solid line and the demand schedule associated with r_1 is indicated with a dashed line. The new intersection of demand and supply for nontradables is at point B. However, at point B, labor demand, indicated with h^d in the figure, exceeds labor supply, $\bar{h}$, and thus point B cannot be supported as an equilibrium. Nominal wages begin rising to eliminate the excess demand for labor. The increase in the nominal wage shifts the supply schedule up and to the left, as shown by the dashed upward-sloping line in Figure 5. The new equilibrium is at point C, where wages are higher (and equal to W_1), relative prices are higher (and equal to p_{boom}), and the economy enjoys full employment. Think of point C as the state of the economy at the peak of the business cycle in 2008Q2. The data underlying Figure 1 indicate that nominal hourly wages in the five countries considered increased about 50 percent over the period 2000 to 2008.

In 2008, the Great Recession hits and borrowing conditions for countries in the periphery of Europe deteriorate rapidly. For simplicity, we represent this deterioration in borrowing conditions as interest rates rising back to $r_0 > r_1$. This rise in interest rates shifts the demand curve back down to its original position, indicated with a solid downward sloping line in Figure 5. However, the economy does not return to point A because nominal wages cannot fall. The economy therefore settles at point D, where labor demand is equal to h_{bust}, which is lower than labor supply, and involuntary unemployment in the amount $\bar{h} - h_{bust}$ emerges. If nominal wages were downwardly flexible, full employment would be restored by a decline in wages that shifts the supply schedule down and to the right. The resulting equilibrium would be at point A, where $h_t = \bar{h}$.

We note that the adjustment of the economy from point C to point D could be viewed as displaying insufficient depreciation of the real exchange rate: the equilibrium real exchange rate, given by p_{bust}, is too appreciated relative to the full employment real exchange rate, given by p_0. The real exchange rate gap shown on Figure 5 as $p_{bust} - p_0 > 0$ means that nontradables are too expensive relative to

Figure 5
Boom Followed by Crisis and Unemployment



Notes: Recall that p is the relative price of nontradables in terms of tradables, h is hours worked, W is the nominal wage rate, P^{*M} is the foreign currency price of traded goods, E is the exchange rate, and $W/P^{*M}E$ is the real wage. Assume that workers inelastically supply $\bar{h}$ hours of work to the market. Suppose the economy starts at point A. Think of this as the location of peripheral Europe in 2000, the year the euro was adopted. Next assume that interest rates fall from r_0 to $r_1 < r_0$. The demand schedule associated with r_1 is the dashed line. The new intersection of demand and supply for nontradables is point B, where labor demand, h^d, exceeds labor supply, $\bar{h}$. Nominal wages begin rising to eliminate the excess demand for labor, which shifts the supply schedule up and to the left. The new equilibrium is at point C, where wages are higher, relative prices are higher, and the economy again enjoys full employment. Think of point C as the state of the economy at the peak of the business cycle in 2008Q2. In 2008, the Great Recession hits and borrowing conditions for countries in the periphery of Europe deteriorate rapidly. For simplicity, we represent this as interest rates rising back to $r_0 > r_1$. This rise in interest rates shifts the demand curve down (to its original position), however, the economy does not return to point A because of downward nominal wage rigidity. Therefore, the economy settles at point D, and involuntary unemployment emerges.

tradables, preventing households from engaging in an expenditure switch away from tradables and toward nontradables. This expenditure switch is necessary to restore full employment in the nontraded sector.

The apparent downward rigidity in the real exchange rate could be interpreted as stemming from nominal rigidities in the price of nontradables. But in the present framework, nominal product prices are fully flexible. The reason why firms in the nontraded sector are reluctant to lower nominal prices further is that their nominal

labor cost, determined by the nominal wage, are too high. Lowering nominal prices would lead to losses that would force firms out of the market. It follows that nominal wage rigidity causes nominal product prices to behave as if they themselves were downwardly rigid.

Domestic Policy Options

The adjustment friction created by downward nominal wage rigidity can be overcome by a number of domestic policy interventions. One such domestic policy would be to devalue the currency—that is, to increase E_t. (Recall that in the above analysis E_t is credibly and permanently fixed.) By deflating the real labor cost faced by firms, a devaluation causes a shift in the supply schedule down and to the right. A sufficiently large devaluation would result in an equilibrium with full employment, indicated by point *A* in Figure 5.

In a theoretical model in Schmitt-Grohé and Uribe (2010), we show that the optimal exchange rate policy consists in large devaluations during external crisis. We also show that the optimal exchange rate policy can restore full employment in all periods and increases welfare, relative to a peg, by more than 5 percent of consumption per period. This numerical value of the welfare benefits is based on a number of modeling assumptions, and thus might not be representative. In the calibration we use, the large welfare benefits arise because the optimal exchange rate policy would lower the unemployment rate in crisis between 5 and 10 percentage points.

Of course, no country in the periphery of the eurozone has (yet) chosen to abandon the euro and devalue its currency. However, other countries that suffered from large adverse external shocks and had pegged their currency have responded to the adverse shock by devaluing. One example is Argentina in 2001. After pegging the peso at a one-to-one parity with the US dollar for more than a decade, Argentina devalued by 250 percent in December of 2001: that is, the peso price of one US dollar went from 1 Argentine peso to 3.5 Argentine pesos. The devaluation followed three years of adverse external shocks that had caused large increases in involuntary unemployment. The Argentine subemployment' rate, which measures the fraction of the workforce that is either unemployed or working part-time involuntarily, increased from 26 percent to 39 percent between 1998 and 2002. As in the recent experience of peripheral Europe, this increase in unemployment did not result in a downward adjustment in nominal wages. On the contrary, nominal hourly compensation costs in manufacturing increased from 7.87 pesos in 1998 to 8.14 pesos in 2001. During this period Argentina experienced deflation of 0.86 percent per year, so real wages actually rose at a time when unemployment increased sharply. When Argentina finally devalued at the end of 2001, real wages declined, falling 65 percent in real terms in 2002. Unemployment also fell rather swiftly and by 2005 subemployment stood again at 25 percent, 15 percentage points below the pre-devaluation peak.

Another historical example of the effectiveness of devaluations in reducing real wages and unemployment has been documented by Eichengreen and Sachs (1985) for the Great Depression. These authors show that countries that left gold early enjoyed more rapid recoveries than countries that stayed on gold. This difference in performance was associated with earlier reflation of price levels in the countries leaving gold. Specifically, Eichengreen and Sachs compare the change in real wages and industrial production from 1929 to 1935 observed in the sterling bloc countries, consisting of the United Kingdom, Sweden, Finland, Norway, and Denmark, and the gold bloc countries, which are France, Belgium, the Netherlands, and Italy. The sterling bloc countries left gold beginning in 1931, and the gold block countries stayed on gold much longer, some until 1935. Eichengreen and Sachs show that, relative to their respective 1929 levels, real wages in the sterling bloc countries were lower than real wages in the gold bloc countries. And industrial production in the sterling bloc countries in 1935 exceeded their respective 1929 levels, whereas industrial production in the gold bloc countries was below their respective 1929 levels.

Certain domestic fiscal policies can mimic the effect of a devaluation of the nominal exchange rate. These policies can, for instance, take the form of a wage subsidy or of a sales subsidy in the nontraded sector. The key characteristic of such policies is that they lower the effective cost of production of firms operating in the nontraded sector. Graphically, the effect of these policies is to shift the supply schedule in Figure 5 down and to the right. If the subsidies are large enough, they can bring the economy from point *D* to point *A* and restore full employment. In Schmitt-Grohé and Uribe (2010, 2012), we discuss this avenue in more detail. As in the case of devaluations, countries in the periphery of the eurozone have not adopted expansionary fiscal policies of the type described here. On the contrary, the observed changes in the fiscal policy stance over the past four years have been toward fiscal austerity. For example, the change in real government spending during the Great Recession in peripheral Europe was negative, whereas in the previous three recessions, government spending rose—by about 25 percent (for discussion, see Box 1.1 of the April 2013 World Economic Outlook).

In the absence of domestic policy intervention, the current situation in the periphery of the euro area is described by point *D*, where unemployment is high and persistent.

Eurozone-wide Policy Options

Given the difficulties that policymakers in the periphery of the eurozone face in adopting domestic policies that stimulate employment, a natural question is whether the required stimulus could originate from supranational European policy institutions. On the fiscal side, the eurozone is not a fiscal union. The revenues and spending of the European Union are quite small relative to the size of the EU economy, and they are not set up in a way to create an effective supranational tax or transfer system.

However, on the monetary policy side, there exists a well-defined institutional framework, embodied in the European Central Bank, to implement eurozone-wide monetary policy. The central bank of the monetary union could ameliorate the unemployment problem created by the combination of downward nominal wage rigidity and a fixed exchange rate. The required policy takes the form of a temporarily higher rate of union-wide inflation. In terms of the notation used here, the central bank of the monetary union should induce a temporary increase in the general price level, P_t^{*M}.

Figure 5 shows how this policy would affect employment in the peripheral countries. The economy starts at point D in which the labor market suffers involuntary unemployment, the nominal wage rate is W_1 and the general price level is P_0^{*M}. Suppose now the central bank creates inflation and this lifts the price level from P_0^{*M} to $P_1^{*M} > P_0^{*M}$. Graphically, the increase in P_t^{*M} shifts the supply schedule (shown with a dashed line) down and to the right, back to the upward sloping solid line in Figure 5.[5] If the increase in the general price level P_t^{*M} is sufficiently large, the equilibrium will be at point A, where the economy displays full employment.

The present analysis suggests that emerging countries of the eurozone could benefit significantly from a temporary increase in union-wide inflation. But what about countries in which the lower bound on nominal wages was not binding during the crisis—arguably Germany, Austria, and the Benelux countries? In these countries, the increase in the general price level P_t^{*M} would result in an increase in nominal wages without affecting employment or production. Graphically, starting from point A in Figure 5 and assuming that for these countries the borrowing conditions did not change significantly (so their interest rate does not change), the increase in the general price level P_t^{*M} shifts the supply schedule down and to the right, and an increase in nominal wages W_t shifts it back to its original position, so the economy never leaves point A. The increase in wages occurs automatically because at the original wage level W_0, the increase in the general price level P^{*M} causes an excess demand for labor. Because wages are assumed to be fully flexible upwardly, the excess demand in the labor market is eliminated spontaneously by an increase in nominal wages.

An implication is that the required level of price increases in the monetary union as a whole is larger than the one that will take place in the peripheral countries in which the lower bound on wages is binding. The reason is that adjustment in the latter countries requires a real depreciation, that is, a fall in the relative price of nontradables, p_t. To see this effect in graphical terms, refer to Figure 5. In the crisis equilibrium, point D, the relative price of tradables p_t equals p_{bust}, which is higher than the full employment equilibrium relative price p_0 associated with point A. Since $p_t = P_t^N/(P_t^{*M}\overline{E})$, in order for p_t to fall, the nominal price of nontradables P_t^N must increase proportionally less than the general increase in the price level P_t^{*M}. The situation is different for the members of the monetary union in which the lower bound on

[5] The demand schedule is unaffected by the increase in foreign prices. In particular, because both P_t^{*M} and P_t^{*X} are assumed to increase in the same proportion, the terms of trade, tot_t, are unchanged.

wages is not binding. There, the real exchange rate is at its full employment level and therefore does not need to change. Consequently, the general increase in the price level P_t^{*M} should be met with an increase in the nominal price of nontradables of the same proportion. It follows that the increases in the overall price level are proportionally larger in countries in which the nominal wage rigidity is not binding.

How Much Union-wide Inflation Is Needed?

How large is the eurozone-wide price increase necessary to eliminate the unemployment problem in the periphery? We present two alternative ways of calculating the size of the required inflationary stimulus. One uses wage data and the other employment data.

A Wage-based Calculation

We assume that real wages observed in the periphery of Europe in 2000Q1 were at trend full employment values. The average cumulative increase in nominal hourly wages observed in the five peripheral countries listed in Figure 1 over the period 2000Q1 to 2011Q2 was 48.7 percent. We proxy foreign inflation by the Consumer Price Index inflation rate in Germany. Over the period 2000Q1–2011Q2, the German price index rose by 20.6 percent.

To take into account by how much full employment real wages rose, we need a measure of total factor productivity growth. It turns out that total factor productivity in the euro area was roughly constant in the past decade. Barkbu, Rahman, and Valdés (2012, figure 2) compute total factor productivity growth for each decade since the 1960s. For the 2000s, they report, for the euro area as a whole, annual total factor productivity growth of less than 0.2 percent. The EU KLEMS Growth and Productivity Accounts project, at http://www.euklems.net, offers valued-added estimates of total factor productivity growth for Spain and Ireland. It reports that by this measure, productivity in Spain fell by 4 percent between 2000 and 2007 and productivity in Ireland fell by 1 percent over the same period. Therefore, we assume that productivity stayed constant, and we only adjust for foreign inflation but not for productivity growth.

It then follows that in 2011Q2 real wages in the five peripheral European countries were on average 23.3 percent above their full employment levels. (This figure results from dividing 1.487 by 1.206; these numbers come from the German price index changes, mentioned above.) Therefore, the implied increase in the eurozone price level necessary to restore full employment is 23.3 percent.[6] If the required price

[6] A further assumption implicit in this calculation is that the full employment real exchange rate (that is, the full employment value of p_t), is the same in 2011Q2 as it was in 2000Q1. This assumption is conservative. It is reasonable to assume that in order to service the increases in external debt observed between 2000 and 2011, the full employment real exchange rate would have to depreciate relative to its 2000 level.

increase were to be implemented in a period of five years, the annual rate of inflation in the eurozone would have to be raised to 4.3 percent. This figure is more than twice as large as the current area-wide inflation target of 2 percent.

An Employment-based Calculation

An alternative way to determine how much euro-area-wide inflation is needed to restore full employment in the periphery of the eurozone is to use data on employment. This methodology does not use data on wages or foreign inflation.

Suppose that current employment in the nontraded sector is 10 percent below full employment. This figure is in line with the unemployment increases observed in Greece, Ireland, and Spain since 2008, but higher than those seen in Portugal and Cyprus. To find by how much real wages exceed full employment real wages, we will use the fact that firms set employment so as to equate the value of the marginal product of labor to the marginal cost of labor, which is the real wage. We can calculate by how much the value of the marginal product of labor falls if employment were to increase back to full employment, that is, if employment were to increase by 10 percent. Then using the fact that in equilibrium the value of the marginal product of labor has to equal the real wage, we can obtain an estimate of the required decline in real wages.

The value of the marginal product of labor in the nontraded sector is the product of the relative price of nontradables and the physical marginal product of labor. Assuming that the (physical) marginal product of labor is proportional to labor productivity, which is true for a large class of commonly used production functions, and assuming a labor share of income of 75 percent, an increase in employment by 10 percent lowers labor productivity by $-(0.75 - 1) \times 10 = 2.5$ percent. That is, a 10 percent increase in employment lowers the physical marginal product of labor by 2.5 percent. If the relative price was unchanged, we would conclude that real wages would have to fall by 2.5 percent to restore full employment. However, the economy will only consume (absorb) more nontraded goods if the relative price of nontraded goods falls. Thus we need to take into consideration the effect of a 10 percent increase in employment on the relative price of nontradables. First note that the percentage increase in nontraded output is equal to the labor share times the percentage increase in labor. With a labor share of 75 percent, a 10 percent increase in employment then increases output of nontradables by 7.5 percent. To find the change in the relative price of nontradables that would induce agents to absorb 7.5 percent more nontraded goods, we can use estimates on the intratemporal elasticity of substitution between traded and nontraded goods.

Existing empirical estimates (for examples, see the survey by Akinci 2011) indicate that the intratemporal elasticity between traded and nontraded consumption is about 0.4. This means that if the relative price of nontradables falls by 1 percent, then the relative consumption of nontraded goods increases by 0.4 percent. From here it follows that if output and hence consumption of nontraded goods increases by 7.5 percent, then the relative price of nontraded goods must decline by $1/0.4 \times 7.5 = 18.75$ percent. It follows that an increase in employment of

10 percent will lower the value of the marginal product of labor in the nontraded sector by 18.75 plus 2.5 percent, which is 21.25 percent. In sum, the employment-based calculation indicates that eliminating 10 percentage points of unemployment necessitates a decrease in the real wage of 21.25 percent.

Because the lower bound on nominal wages is binding and the exchange rate is fixed, all of the decrease in the real wage must come from an increase in the general price level P_t^{*M}. That is, the monetary authority of the Euro area must engineer an increase in the overall price level of 21.25 percent, or about 4 percent per year for five years. This level of inflation is essentially the same as the one obtained in the previous subsection using a methodology that relies on observations of wages, total factor productivity growth, and foreign inflation.

Discussion and Conclusion

Clearly, downward nominal wage rigidity is an adjustment friction that is less likely to have negative real effects—that is, it is less likely to be associated with inefficiently high real wages, inefficiently high real exchange rates, and inefficiently low employment—in recessions in which inflation remains strong. Specifically, if inflation is sufficient to make the full employment real wage attainable without having to cut nominal wages, then downward nominal wage rigidity should not matter. Thus, an important aspect of the current recession in Europe is that it occurs in the context of low inflation targets of the monetary authority. The monetary policy objective of the European central bank is to keep inflation below but close to 2 percent per year. Moreover, the monetary authority has been undershooting its inflation target slightly over the course of the recession. In April 2013, year-over-year euro-area inflation, as measured by the harmonized index of consumer prices, was 1.2 percent, 0.8 percentage points below target.

Downward nominal wage rigidity is, of course, not the only possible explanation for the observation that nominal wages have failed to decline in peripheral Europe. For example, some explain the observation that aggregate wages have failed to decline by a composition effect, according to which during a recession low-productivity workers lose their jobs more frequently than do high-productivity workers. Under this hypothesis, average wages do not decline because the workforce has a larger share of high-wage workers. But even so, we would still expect to see wage cuts for those workers (whether low- or high-productivity) who do keep their jobs; however, micro evidence on wage changes of individual workers shows that nominal wage cuts are rarely observed in low-inflation recessions.

For example, Fortin's (1996) study of downward nominal wage rigidity chronicles price, wage, and unemployment during the great Canadian slump of the 1990s, when inflation was low, around 1.4 percent. Fortin shows that the distribution of nominal wage changes during this time had a large mass at zero and otherwise looks like the right tail of a normal distribution. Similarly, Daly, Hobijn, and Lucking's (2012) study of downward nominal wage rigidity in the United States documents

wage changes during the Great Recession of 2008, a period characterized by low inflation (about 1.7 percent on average) and high unemployment. Daly et al. show that the distribution of nominal wage changes of individuals in 2011 has a large spike at zero, and much fewer wage cuts than wage increases. Likewise, the study of Fehr and Goette (2005) is motivated by the great slump that affected Switzerland in the 1990s in which nominal wage cuts were almost never observed in a sample of 35,000 wage changes taken from firms and average inflation was below 1 percent per year. Finally, perhaps the most well-known, recent example of a recession coupled with low inflation is that of Japan in the 1990s. During that decade the Japanese unemployment rate more than doubled, but Kuroda and Yamamoto (2003) document downward nominal wage rigidity in Japan over the period 1993–1998, a time when nominal price inflation was not only low but negative. Taken together, this empirical evidence seems consistent with the assumption that in low-inflation recessions, observed nominal wages do not decline because of downward nominal wage rigidity.

In this essay, we have investigated the consequences of downward nominal wage rigidity for the adjustment of employment in the periphery of Europe to the large negative external shock caused by the 2008 global Great Recession. We show that in an environment of low inflation, downward nominal wage rigidity can prevent a decline in real wages. Absent an adjustment in real wages, the relative price of nontradables cannot fall—that is, the real exchange rate cannot depreciate—causing involuntary unemployment in the economy. We discuss a number of alternative policy options to address the distortions created by downward nominal wage rigidity in a currency union. We argue that, while there are several options, a particularly simple and practical solution lies in increasing inflation in the currency union as a whole. Specifically, our findings suggest that a policy of 4 percent inflation for five years would go a long way towards bringing unemployment down to pre-crisis levels.

Our proposed temporary inflation policy is not of the beggar-thy-neighbor type. In our framework, increasing euro-area-wide inflation is beneficial even if it has no effect on the terms of trade, that is, even if it has no effect on the relative price of exported and imported goods, and even if it has no effect on the trade balance of the country whose employment will benefit from euro-area-wide inflation. Thus our argument is not one of increasing the competitiveness of the periphery relative to the core of the currency union. In this sense, our argument is related to that put forth by Eichengreen and Sachs (1985) for how recovery from the Great Depression could have been hastened. These authors argue that during the Great Depression of the 1930s, devaluations taken by a group of countries were mutually beneficial to those countries and had those policies been more widely adopted and internationally coordinated, they would have sped up the recovery from the Great Depression. Furthermore, the effectiveness of our proposed policy does not hinge on the euro depreciating relative to other currencies, because the success of the policy depends on changing the domestic price of nontraded goods in terms of traded goods and not on changing the terms of trade of Europe relative to the rest of the world.

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