THE LENGTH AND THE DEPTH OF THE GREAT DEPRESSION: AN INTERNATIONAL COMPARISON

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ABSTRACT

This paper examines the hypotheses that the length and the depth of the Great Depression were a result of sticky prices or sticky nominal wages using panel data for industrialized and semi-industrialized countries. The results show that price stickiness, particularly, and wage stickiness were key propagating factors during the first years of the Depression. It is found that prices adjusted slowly to wages, particularly in manufacturing. Manufacturing wages are also found to adjust relatively slowly to innovations in prices, but unemployment exerted strong downward pressure on wage growth.

1. INTRODUCTION

The role of nominal rigidities during the Great Depression has a long history. Starting from Keynes (1936, 1939), Dunlop (1938) and Pigou (1933), a large body of literature has examined why the supply side was so slow to adjust to nominal demand shocks during the Great Depression. Following the long tradition of English economists, Keynes (1936) argued that wages are stickier than prices; however, based on the empirical findings of Dunlop (1938), Keynes (1939) conceded that prices may be stickier than wages due to monopoly pricing but, at the same time, he urged more empirical effort to uncover the relative importance

Research in Economic History
Research in Economic History, Volume 22, 239–288
© 2004 Published by Elsevier Ltd.
ISSN: 0363-3268/doi:10.1016/S0363-3268(04)22005-5

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of price and wage stickiness in depressions in general. A more international approach was initiated by Eichengreen and Sachs (1985) using cross-country data for the industrialized and the semi-industrialized countries. Their evidence suggests that the length and the depth of the Depression across countries were strongly influenced by cross-country changes in nominal wages deflated by wholesale prices, and they argue that the price decline had adverse supply effects because sticky nominal wages prevented goods and labor markets from clearing. Using a more formal panel data approach, Bernanke and Carey (1996), henceforth B&C, show that the real wage channel was indeed a robust one in explaining the cross-section and time-series path of industrial production during the Depression. Furthermore, they find that nominal wages failed to respond to the increasing unemployment and only partially adjusted to the decreasing (wholesale) prices.

Beenstock and Warburton (1986) argue that rising wages deflated by wholesale prices were the cause of the British unemployment over the period from 1929 to 1932.[1] Bordo et al. (2001) show, from simulations of a general equilibrium model, that sticky nominal wages played an important role in propagating the monetary shocks during the 1929–1933 downturn in the U.S. Using the Layard-Nickell model of unemployment, Dimsdale, Nickell and Horsewood (1989) investigate sticky wages and sticky prices as possible explanations for the unemployment effects of the nominal demand shocks in the U.K. during the Depression. They find that nominal wage inertia and mismatch were mainly responsible for the increase in unemployment in the U.K. during the first years of the Depression and that lower import prices pushed up real wages in excess of their warranted level.

The sticky wage hypothesis has not gone unchallenged, however. Bernanke and James (1991) and Eichengreen and Hatton (1988) suggest that there was not a clear-cut correlation between real wages and production when wages are deflated by a more appropriate deflator, namely product prices, for the U.K., the U.S., Germany, Japan and Sweden. Eichengreen and Hatton (1988) furthermore note that real product wages did not increase in Germany, despite Germany having one of the most severe depressions. Bernanke (2000) finds that "only when the [financial] PANIC variable is included does nominal wage growth have the correct (negative) sign . . . but it is not statistically significant" (p. 101). Regressing industrial production on prices and nominal wages, among other variables, Bernanke and James (1991) find that the estimated coefficients of nominal wages are insignificant. Dighe (1997) argues that the sticky wage hypothesis is inconsistent with the employment path from mid-1931 to mid-1933 in the U.S. and finds that the real wage increase from 1929 to 1931 was no more severe than in other contractions in the U.S. economy.

Cole and Ohanian (1999) show that the detrended real wage in the U.S. between 1929 and 1933 decreased by almost 15% for the whole economy and rose only modestly for manufacturing. Based on this and other evidence, Cole and Ohanian (1999, 2001) argue that the sticky wage hypothesis is inconsistent with the evidence for the U.S. Based on a review of the collection of essays by Bernanke (2000), Margo (2000) concludes that wage stickiness remains an economic puzzle.

Despite the critique, the sticky wage hypothesis has not been exposed to a systematic examination using more adequate cross-country sources of data. Previous international studies have focused solely on the manufacturing sector, have used severely biased price deflators, and have not investigated the sensitivity of the results to different sources of data, different sectoral coverage, different estimators, and cross-country variations in wage stickiness. More importantly, the alternative source of supply failure, the sticky price hypothesis, has not been rigorously examined, and rarely stressed as a possible source of supply failure. As shown below, sufficiently flexible prices could have cleared the goods and labor markets, except in the extreme case of completely sticky wages. Hence, some price stickiness must have prevailed under the sticky wage hypothesis.

This paper examines sticky wages and sticky prices as possible sources of supply failure during the Depression, taking the approach that both sources of stickiness were potentially important and that one source of stickiness cannot be identified in isolation from the other. Acknowledging the less-than-perfect quality of the data, the sensitivity of the estimates to different sources of data, different sectoral coverage, different estimation periods, and different estimators that allow for errors-in-variables, is examined. Annual data are used throughout the manuscript due to data availability.

2. CASUAL EVIDENCE ON REAL WAGES AND OUTPUT DURING THE DEPRESSION

Figure 1 presents the unweighted international average of real hourly wages for manufacturing and for the whole economy over the period from 1925 to 1937. The manufacturing wage data are from the same sources as those used by B&C, and are discussed, along with the other data, in the next section. Series 1 is average manufacturing wages deflated by wholesale prices and covers the 22 countries included in B&C's sample. This series shows a 23% increase in real wages from 1929 to 1931, a slight increase from 1932 to 1933 and thereafter a slow decline. This time-profile suggests widespread nominal wage rigidity in the sense that wages failed to respond to the decreasing prices and increasing unemployment, at least in the first years of the Depression.

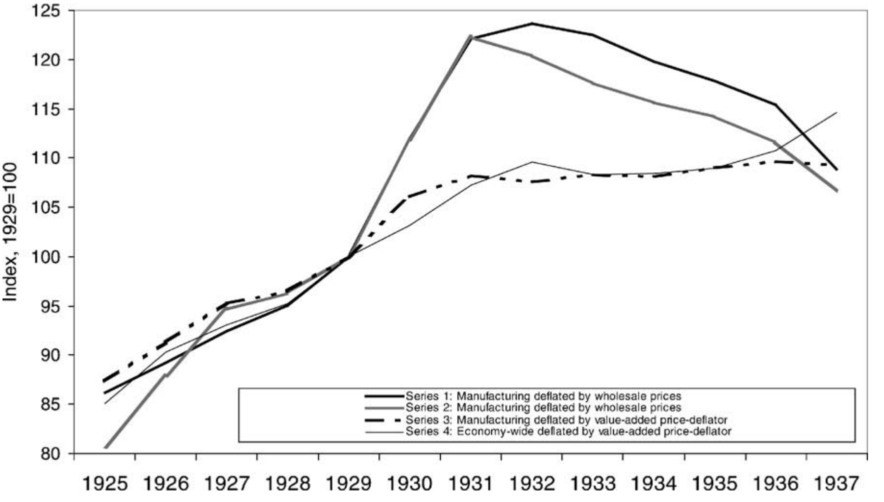

Fig. 1. Real Wages. *Notes:* The following countries are included in the series. *Series 1*: Argentina, Austria, Australia, Belgium, Canada, Czechoslovakia, Denmark, Estonia, France, Germany, Hungary, Italy, Japan, Latvia, Netherlands, New Zealand, Norway, Poland, Sweden, Switzerland, the U.K., and the U.S. *Series 2*: Australia, Canada, Denmark, France, Germany, Italy, Japan, Spain, Sweden, the U.K., and the U.S. *Series 3*: Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Spain, Sweden, the U.K., and the U.S. *Series 4*: Canada, Finland, France, Germany, Japan, Netherlands, the U.K., and the U.S.

Deflating manufacturing wages with the manufacturing value-added price deflator (Series 3) yields an 8% increase in real wages from 1929 to 1931 and an almost unaltered real wage thereafter. When using the manufacturing value-added price deflator, the modest increase in real wages in the first years of the Depression suggests that wage stickiness played a less important role in the supply failure than if wholesale prices are used as deflators. Using economy-wide data where economy-wide hourly labor costs are deflated by the economy-wide value-added price deflator for 8 countries for which data are available (Series 4) shows almost the same path as the manufacturing value-added deflated wages. Real wages increased by 7% from 1929 to 1931 and remained almost unaltered thereafter.

Given that Series 3 is constructed for only 12 countries for which the manufacturing value-added price deflator or producer prices are available, Series 1 and 3 are not strictly comparable. However, using almost the same country set does not alter the conclusion. Series 2 shows manufacturing wages deflated by wholesale prices for the 10 countries that are jointly contained in Series 1 and 3.[2] Series 1 and 2 move closely together, which suggests that the distinctive path between the wholesale deflated (Series 1) and value-added deflated (Series 3) series does not reflect a country selection bias.

In conjunction with the doubts already raised in the literature as detailed in the Introduction, these results raise doubts about whether wage stickiness could have been solely responsible for the supply failure during the Depression. If the supply failure during the Depression was a result of increasing real wages, why did the real wage increase over the period from 1925 to 1929 not produce a Depression, assuming that the growth rates in the full employment marginal productivities of labor were the same over the periods 1925–1929 and 1929–1933? Wholesale-price-deflated wages (Series 1) increased by approximately 20% from 1925 to 1929, which corresponds to the increase in wholesale prices deflated wages over the period from 1929 to 1933. The value-added-deflated real wage series show's an almost constant growth rate over the period from 1925 to 1933. If the supply failure was predominantly due to sticky wages, then real wages should have moved counter-cyclically and not pro-cyclically over the period from 1925 to 1929, assuming that the income fluctuations were mainly demand driven. Hence, real wages should have decreased, or at least have increased at a slower rate, over the period from 1925 to 1929.

Turning to cross-country evidence, Fig. 2 shows little relationship between changes in manufacturing production and changes in manufacturing real product wages across countries over the downturn period from 1929 to 1932. Least squares regression suggests that there is not a statistically significant relationship between the change in real wages and the change in industrial production over the period 1929–1932, as shown in the first column of Table 1, regardless of whether wages are deflated by the value-added price deflator or wholesale prices. The estimates using wholesale prices include the 22 and 10 countries that are considered by B&C and Eichengreen and Sachs (1985), respectively. A weak,

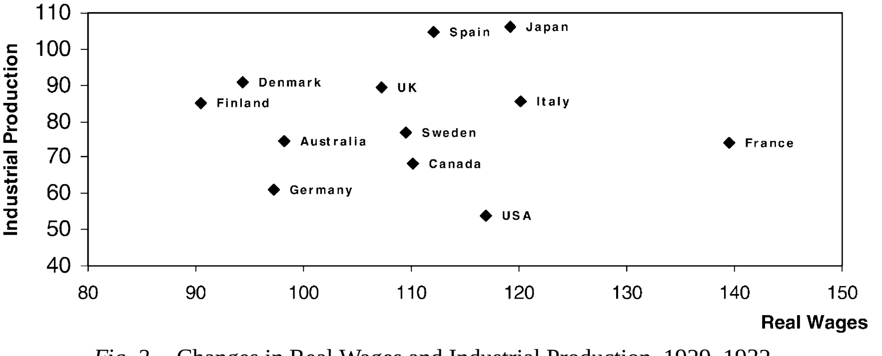

Fig. 2. Changes in Real Wages and Industrial Production, 1929–1932.

Table 1. Estimates of Cross-section Output Equations.

		1929–1932	1932–1936	1929–1935
1	$N = 12$, PMAN	0.00 (0.01)	0.01 (0.04)	0.02 (0.17)
2	$N = 10$, WPI	0.14 (0.64)	−0.35 (0.67)	−0.38 (1.99)
3	$N = 22$, WPI	0.02 (0.17)	−0.76 (1.76)	−0.76 (1.76)

Notes: The change in the log of industrial production over the specified period regressed on the change in the log of real wages over the same period. WPI signifies that the wholesale price deflator has been used and PMAN signifies that the manufacturing value-added price deflator has been used. The numbers in parentheses are absolute *t*-statistics. Constant terms are included in the estimates but not shown. $N = 22$ are the 22 countries included in the estimates by B&C. $N = 12$ are the 12 countries for which manufacturing prices are available, and include the countries listed in the notes to Fig. 1. $N = 10$ are the 10 countries considered by Eichengreen and Sachs (1985).

statistically significant negative relationship between real wages can only be identified in the recovery phase from 1932 to 1936 if the B&C sample is used (second column). Considering the period from 1929 to 1935 in column 3, as done by Eichengreen and Sachs (1985), there is only a significant negative relationship between output and real wages if wholesale prices are used as the deflator and if the country sample of Eichengreen and Sachs (1985) is employed.[3]

The lack of a well-defined negative relationship between changes in industrial production and real wages is either: (1) because price stickiness played an important role and therefore that demand shocks did not result in movements along the labor demand schedule but a shift thereof; (2) because countries were exposed to supply shocks of different intensities; or (3) that the data are error-ridden. Hence, identification of sources of supply failure during the Depression requires a more careful analysis, which is undertaken in Sections 5, 6 and 7.

Overall the casual evidence in this section suggests that neither sticky wages nor sticky prices could have been the sole explanation for the supply failure. First, if sticky wages were the sole explanation for the supply failure, then real product wages would have increased in all the countries that experienced a downturn during the Great Contraction from 1929 to 1932. However, real product wages decreased in Australia, Denmark and Finland over the period from 1929 to 1932/33. Second, given that industrial production fell on average by 20.6% in the 12 countries listed in Fig. 2, and real wages increased by less than 10% over the period from 1929 to 1932, an implausibly high real wage elasticity of output is required to render the sticky wage hypothesis as the sole explanation for the supply failure. Third, since real product wages increased almost as much from 1925 to 1929 as from 1929 to 1933, the 1925–1929 increase in real wages would have been consistent with a downturn, not an upturn. Fourth, since the average real wage increased from 1929 to 1932, the wage setting schedule must have shifted to the left in response to the adverse demand shocks. Nominal wage stickiness must consequently have played a role since supply shocks were predominantly positive, such as the reduction in real commodity prices.

3. DATA ISSUES AND THE MEASUREMENT OF WAGES AND PRICES

One of the largest difficulties associated with the identification of the source of supply failure during the Depression is that wage and price data are measured with large errors and that the measurement errors in some of the data are likely to move systematically over time. The question is which data are the least likely to be measured with error and how to control for the errors-in-variables problem in the estimates.

Why is the wholesale price index a misleading wage deflator? First, for most countries, non-manufactured raw materials weighed more than 50% in the wholesale price index (United Nations, 1954), and thus the collapse in commodity prices contributed substantially to the decline in wholesale prices in the first years of the Depression. For the U.S. over the period from 1929 to 1932, for instance, raw material prices fell by 47.8% (Warren & Pearson, 1937), whereas prices of industrial commodities decreased by only 23.2% (Liesner, 1989). Madsen (2001a) shows that the decline in agricultural prices dominated the decline in wholesale prices and argues that the agricultural decline was an important contributor to the Depression. Hence, the apparent influence on output of higher wages deflated by wholesale prices may be an illusion driven by the agricultural crisis.

Another problem that is associated with the use of the wholesale price index is that it contains a large component of imported products (United Nations, 1954, p. 125). For New Zealand, for example, imported products had a weight of 58% in the wholesale price index. Furthermore, for a large proportion of countries, the wholesale price index *included* imports but *excluded* exports (United Nations, 1954, p. 154). This is contrary to the value-added principle, where imports are excluded but exports included.

The heavy weight of import prices in the wholesale price index gives rise to serious problems in multi-country analyses of the downturn from 1929 to 1932/1933. In particular, one would expect to find that wholesale prices *decreased* the least in countries that depreciated their currencies and increased their tariffs on imports the most. This partly explains the finding of Eichengreen and Sachs (1985) that countries that were the first to go off the gold standard were also the first to recover from the Depression and experienced the least increase in real wages.[4]

Deflating wages by wholesale prices is not only erroneous because prices of crude food and materials carried a large direct weight in the wholesale price index, but also because the output effects of changes in real commodity prices are not correctly accounted for when the wholesale price deflator is used. To see the latter more explicitly, consider the supply function for the firm under perfect competition:[5]

$$Y^{\mathrm{o}} = F\left(K, Q^{\mathrm{c}}, \frac{W}{P^{\mathrm{o}} - P^{\mathrm{c}}\partial Q^{\mathrm{c}}/\partial Y^{\mathrm{o}}}\right) \tag{1}$$

where Y^{o} is gross output, K is the capital stock, Q^{c} is the quantity of intermediate products, P^{o} is the output price, and P^{c} is the price of intermediate products. Here gross output is a positive function of the capital stock and intermediate products and a negative function of real wages. Wholesale prices are given as a weighted sum of P^{o} and P^{c} and prices of other products. The indirect bias from using wholesale prices as the deflator in real wages is that the decline in P^{c} lowered wholesale prices, thus increasing real wages, but should have resulted in a positive output response because $[P^{\mathrm{o}} - P^{\mathrm{c}}\partial Q^{\mathrm{c}}/\partial Y^{\mathrm{o}}]$ increased.

The only way to identify the supply schedule under the maintained hypothesis of perfect competition in the goods market is to deflate wages with either the value-added price deflator or with producer prices, while allowing real raw material prices to enter as separate arguments in the supply function. Since economy-wide value-added price deflators are available for some countries, the data requirements are met on an economy-wide scale. For manufacturing, however, the value-added price deflator is only available for a few countries, as detailed in the Data Appendix. For additional countries where manufacturing output prices are available, value-added price deflators are constructed as $(0.8P^{\mathrm{o}} - 0.2P^{\mathrm{c}})$ where the prices were normalised to one on average over the period from 1926 to 1937.[6] Although the value-added price deflator constitutes a major improvement over wholesale prices, it is still subject to measurement errors, which are dealt with in various ways as discussed below.

The wage data are also measured with a large error that is probably much more serious than the measurement error in the value-added price deflator. There are two potential sources of errors in the wage data. First, hourly manufacturing earnings for both skilled and unskilled workers are only available for five out of the 24 countries considered here (U.S., Italy, Latvia, Poland and Spain). For the remaining 19 countries the wage data are of wider or different sectoral coverage than manufacturing, cover only a portion of the manufacturing employment (skilled workers, unskilled workers, capital city, men, *etc*.), or are recorded on a daily or weekly basis as detailed in the Data Appendix. These resulting of errors are likely to be substantial.

Second, compositional changes may have biased wage changes. Cole and Ohanian (2001), Lebergott (1989) and Margo (1993) argue that the proportion of low wage earners decreased during recessions because the cyclical sensitivity of hours worked was higher for unskilled than skilled workers, thus biasing the fixed weight index of aggregate wages. They further argue that these compositional effects were particularly strong during the Depression, thus overstating the change in money wages over the period from 1929 to 1933. Moreover, Lebergott (1989) argues that the bankruptcy frequency was more pronounced among low pay firms. However, microeconomic evidence on wage rigidity is not consistent with these results (see Dighe, 1997; Hanes, 2000; Simon, 2001). Furthermore, comparing official aggregate wage indexes with fixed weight indexes derived from international occupational data for nine countries, B&C were unable to detect an aggregation bias in official aggregate wage indexes due to compositional effects. The importance of compositional effects in aggregate wage data is therefore not clear.

What are the solutions to the measurement problems? The recommended solution to an errors-in-variables problem is to use instruments that are orthogonal to the measurement errors but highly correlated with the true variation in the variables and furthermore to use robust estimators if the instruments are weak. Due to the presence of both errors-in-variables and simultaneity problems in the estimates in this paper, however, consistent estimates can only be recovered if exogenous demand shifters, which are simultaneously uncorrelated with the measurement errors, are available. Unfortunately, this is not likely to be the case since the measurement errors in the data and particularly in wages, are likely to be correlated with the business cycle and therefore correlated with the exogenous demand shifters.

It is therefore unlikely that instruments and robust estimators alone can solve the consistency problem. A complementary approach is called for. In addition to using instruments and alternative estimators, the sensitivity of the estimation results to different data sources, data coverage, instrument set, and restrictions imposed on the estimates, is examined. Furthermore, the sample is made as large as possible because the instrumental variable method does not yield unbiased estimates (Hahn & Hausman, 2002). The econometric methods that are used to deal with these issues are discussed in Section 5.

Three different sources of wage data are used: Economy-wide hourly labor costs and two sets of hourly earnings, which in sectoral coverage are as close to manufacturing as possible using the same data sources as B&C (mainly ILO's *Yearbook of Labor Statistics*). However, some countries have more than one potential useful wage series and it is not clear which is the best proxy for manufacturing hourly earnings. For Japan, for instance, two series for industrial daily earnings are reported in ILO's *Yearbook*: One series is published by the Imperial Cabinet and another is published by the Bank of Japan. Without detailed knowledge of the data sources, sample, sampling method etc., it is not obvious which wage data are of the highest quality and the most representative for manufacturing hourly earnings. Hence, the data are subdivided into two sets. The first set is the same as the one used by B&C, judged from their Fig. 1, and the other set contains the same data as used by B&C except for six countries for which alternative data are available.

Three different deflators are used; namely wholesale prices, the manufacturing value-added price deflator, and the economy-wide value-added price deflator. The reasons for estimating for manufacturing is because all international studies have focused on this sector and because the supply schedule is relatively well defined in this sector.[7] Economy-wide data cover the whole economy and include indirect labor costs, such as contributions to social security and private pension funds, family allowances and private health insurance, which are not included in manufacturing wage data. Furthermore, economy-wide data are likely to be of a higher quality than manufacturing data given the importance that is attributed to economy-wide compensation to employees and value-added price deflators. Finally, only economy-wide data can be used to simulate the effects on economy-wide unemployment of various sources of supply failure using the model that is presented in the next section. These considerations suggest that manufacturing and economy-wide data are useful complements in identifying the sources of supply failure during the Depression.

4. A MODEL OF THE SUPPLY SIDE DURING THE DEPRESSION

To analyse the sources and the consequences of the supply side failure during the Depression this section sets up a small supply model consisting of price and wage setting, which jointly determine the evolution of output at any given demand. The model draws on the model of Dimsdale, Nickell and Horsewood (1989), but differs in its treatment of import prices and allows for a Phillips curve effect in wage adjustment, that is, the deviation of unemployment from its natural rate is allowed to persistently affect wage growth. The latter feature is crucial for the persistence of shocks.

Firms. The individual producer's production function is given by:

$$Q_i = L_i^a,$$

where Q is output and L is labor inputs and a is a constant, $0 < a \leq 1$.

The demand for firm *i*'s products is given by the equation:

$$Q_i^{\mathrm{D}} = Y\left(\frac{P_i}{P}\right)^{-\eta}$$

where η is the price elasticity of demand, Y is aggregate value-added real income, P_i is the value-added price charged by the individual firm, and P is the general price level. The profit maximizing problem of the firm is given by:

$$\max_{(P_i/P)} \Pi_i/P = \frac{P_i}{P}Q_i - \frac{W}{P}L_i = \frac{P_i}{P}Y\left(\frac{P_i}{P}\right)^{-\eta} - \frac{W}{P}L_i \tag{1}$$

where Π is nominal profits. This optimization problem yields the solution as follows:

$$\frac{P_i}{P} = \frac{\eta}{\eta - 1}\frac{W}{P}\frac{L}{Q}a^{-1}, \tag{2}$$

which shows that the producer with market power sets price as a mark-up over marginal costs. Assuming asymmetry and that the price elasticity of demand is a function of demand, this equation can be written as:[8]

$$P = Y^{\theta}W^{\mathrm{e}}\left(\frac{L}{Y}\right)^{\mathrm{e}}a^{-1}$$

where $\eta/(\eta - 1) = Y^{\theta}$ and the superscript "e" stands for expectations. Decomposing expected wages and taking logarithms yields the price-setting equation as follows:[9]

$$p = \theta y + w - w^{\mathrm{u}} + (l - y)^{\mathrm{e}} - \ln(a) \tag{3}$$

where lowercase letters signify logs of capital letters, and $w^{\mathrm{u}} = w - w^{\mathrm{e}}$, is unexpected wages. This equation suggests that the mark-up of prices over marginal cost is a function of the output and wage surprises. Wage surprises influence mark-up by creating a wedge between the wage that firms expect to prevail when they set prices, and the actual wage outcome. If it is costly to change prices an unexpected wage reduction will increase mark-ups and reduce output.

Wage setting. Consider the following standard wage setting model (Dimsdale et al., 1989; Madsen, 1998):

$$w = \alpha_0 + p^{\mathrm{e}} + \alpha_1(p^{\mathrm{cpi}} - p)^{\mathrm{e}} + \alpha_2 y + (y - l)^{\mathrm{e}} + z$$

where p^{cpi} is the log of consumer prices and z is a vector of wage push variables. Here, wages are indexed to the expected value of the value-added price deflator on a one-to-one basis following the natural rate hypothesis. Since the consumer price index is the relevant deflator for workers, the wedge between consumer prices and the value-added price deflator influences the wage outcome by the proportion α_1, which is determined by the relative bargaining position between firms and workers among other factors. Wage push factors, including the term $(p^{\mathrm{cpi}} - p)$ are factors that push wages away from their full employment equilibrium. Excess demand for labor is measured by output to simplify the exposition in this section. This assumption is relaxed in the sections below.

Decomposing expected prices yields:

$$w = \alpha_0 + p - p^{\mathrm{u}} + \alpha_1(p^{\mathrm{cpi}} - p)^{\mathrm{e}} + \alpha_2 y + (y - l)^{\mathrm{e}} + z \tag{4}$$

where $p^{\mathrm{u}} = p - p^{\mathrm{e}}$ is unexpected prices and incorporates the wage-effects of price shocks due to contractual arrangements and co-ordination failures. If workers fail to coordinate a concerted reduction in nominal wages as a result of price deflation, then real wages will rise due to a widening of the gap between the expected and actual prices, $(p^{\mathrm{e}} - p)$.

Demand. Demand is a positive function of real money balances, M/P, and other demand shifters, X,

$$y = (m - p) + x. \tag{5}$$

Equilibrium. Solving Eqs (3) and (4) yields the output equation as follows:

$$y = \frac{p^{\mathrm{u}} + w^{\mathrm{u}} - \alpha_1(p^{\mathrm{cpi}} - p)^{\mathrm{e}} - z + \alpha_0 + \ln(a)}{\theta + \alpha_2}. \tag{6}$$

In this model unexpected demand shocks have output effects because they change real *ex post* wages and mark-ups via the terms p^{u} and w^{u}. The output effects of demand shocks depend on four parameters: p^{u}, w^{u}, θ, and α_2. Here, p^{u} and w^{u}, depend on the size of the demand shock and nominal rigidity. The parameters θ and α_2 represent the adjustment of prices and wages to disequilibria in the labor and goods markets. If prices and wages are sensitive to demand shocks, then θ and α_2 will be large and the output effects of demand shocks muted. In other words, the slope of the aggregate supply schedule is steep.

In the model p^{u} and w^{u} need not only signify unanticipated outcomes but can also represent co-ordination failures among workers and firms. If a price deflation fails to cause a proportional reduction in nominal wages, then p^{u} decreases and output declines. The same applies for firms if they fail to coordinate a price reduction when demand and wages fall. Under the assumptions of sticky wages but flexible prices and no price confusion, $w^{\mathrm{u}} = 0$ in the price equation, and demand shocks influence output via the p^{u} term. Conversely, under the assumptions of sticky prices but flexible wages and no price confusion among workers, $p^{\mathrm{u}} = 0$ and demand influences output via the w^{u}-term.

When price and wage expectations are met, and hence $p^{\mathrm{u}} = w^{\mathrm{u}} = 0$, output settles at its potential, which corresponds to the natural rate of unemployment:

$$y = \frac{-\alpha_1 (p^{\mathrm{cpi}} - p)^{\mathrm{e}} - z + \alpha_0 + \ln(a)}{\theta + \alpha_2}.$$

Equation (6) is derived under the assumption that output, or more correctly the deviation of output from its potential, does not permanently affect the wage growth rate. This follows the framework of Layard and Nickell (1986) and is popularized by Blanchflower and Oswald (1994), who argue that the labor market is represented by a wage curve and not a Phillips curve, and, as a consequence, unemployment affects only the level of wages when unemployment changes. Once unemployment has stabilised after a shock, wages remain unaffected by the level of unemployment. This stands in contrast to the traditional Phillips curve framework where unemployment in excess of its equilibrium continues to put downward pressure on wage growth until the labor market disequilibrium is eliminated. The wage curve assumption is restrictive since several contemporaneous studies of the labor market find significant Phillips curve effects (see for instance the special issue on the Phillips curve in the *Journal of Monetary Economics*, *44*(2), 1999).

A Phillips curve effect can be incorporated into the model by writing Eqs (3) and (4) in first-difference form and adding to the first-differenced wage equation the terms $\alpha_3 y_t$ and α_4, where α_4 is potential output corresponding to the natural rate of unemployment. This yields the output equation as follows:

$$y_t = \frac{\alpha_2 + \theta}{\alpha_2 + \alpha_3 + \theta} y_{t-1} + \frac{\dot{p}^{\mathrm{u}} + \dot{w}^{\mathrm{u}} - \alpha_1 (\dot{p}^{\mathrm{cpi}} - \dot{p})^{\mathrm{e}} - \dot{z} + \alpha_4}{\alpha_2 + \alpha_3 + \theta}. \quad (7)$$

This equation gives important information about the persistence of demand and supply shocks during the Depression. If wage growth is not allowed to depend on the level of output (unemployment), then α_3 and α_4 are zero, which implies that supply shocks have permanent output effects and demand shocks have persistent output effects. This aspect is analysed in Blanchard and Katz (1997).

Suppose instead that there is no wage curve effect ($\alpha_2 = 0$) and that prices are unaffected by demand shocks ($\theta = 0$), then Eq. (7) collapses to:

$$y_t = \frac{\dot{p}^{\mathrm{u}} + \dot{w}^{\mathrm{u}} - \alpha_1 (\dot{p}^{\mathrm{cpi}} - \dot{p})^{\mathrm{e}} - \dot{z} + \alpha_4}{\alpha_3},$$

which shows that supply shocks have only one-off effects on output and unemployment and demand shocks do not have persistent output effects because lagged output does not feed into current output. Intuitively, a shock that shifts the wage setting and the labor demand curves to the left increases the rate of unemployment. The higher unemployment puts downward pressure on wage growth and the wage setting schedule continuously shifts to the right until unemployment is eliminated. In the presence of a wage curve effect, output will also converge towards its initial equilibrium following a shock as long as the Phillips curve effect prevails, as seen from the coefficient of lagged output in Eq. (7).

The adjustment in wages to the deviation in output and unemployment from their natural rates is therefore crucial to the persistence of demand shocks during the Depression, regardless of whether the supply failure was a result of labor market or goods market rigidities, and should therefore not *a priori* be ruled out in the empirical testing. Furthermore, since the adjustment of wages to price surprises, including downward nominal wage rigidity, cannot be adequately modeled given the difficulties that are associated with the measurement of price expectations and co-ordination failures, the unemployment term will automatically capture the part of the price surprise effect of a demand shock that is not captured by the price expectational error term. The change in the unemployment term, however, will not be able to capture the measurement errors in price surprises that last more than one year.

Equation (7) is the key equation in the paper and will be used to determine the role of sticky wages and prices in the supply failure in the simulation exercises in Section 8. The model will be based on the estimates in the next sections. Before presenting the empirical estimates, the implications of wage and price rigidities on output and real wages are analyzed.

4.1. *Demand Shocks Under Sticky Nominal Wages*

Suppose that nominal wages are constant, $w = w^{\mathrm{e}} = \bar{w}$, and prices are flexible. Then the solution to Eqs (3) and (5) gives the equilibrium output as follows:

$$y = \frac{m + x + \ln(a)}{1 + \theta} - \frac{\bar{w}}{1 + \theta} + \frac{(y - l)^{\mathrm{e}}}{1 + \theta}.$$

In this scenario output is demand determined and is only influenced by the supply side due to productivity shocks that lower marginal costs. Since expected productivity probably did not change much during the Depression, this equation shows that output is solely demand driven and that wage push factors are unimportant for output since nominal wages are assumed to be fixed.[10] This model corresponds to a flat aggregate supply schedule.

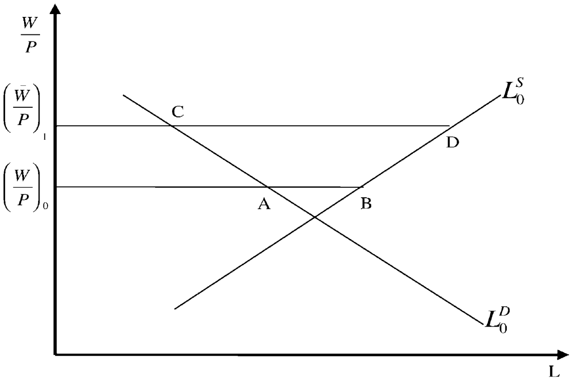

Fig. 3. Sticky Wages, Flexible Prices, and Competitive Goods Market.

Figure 3 illustrates the behavior of real wages following an adverse demand shock, where (*W/P*) is real wages, *L* is labor, and L^S and L^D are labor supply and demand curves. The real wage is initially given by $(\overline{W}/P)_0$ and the distance between *A* and *B* gives the number of unemployed. An adverse demand shock reduces prices and brings real wages up to $(\overline{W}/P)_1$ and the number of unemployed increases to the distance between *C* and *D*. The labor demand curve remains unaffected by the demand shock because the goods market is assumed to be perfectly competitive and therefore price mark-ups over marginal costs are constant at one. In this case real wages are counter-cyclical and firms will always be on their notional labor demand curve given by Eq. (3).

4.2. Demand Shocks Under Sticky Prices

If prices are sticky ($p = \overline{p}$) but wages are flexible, then Eq. (5) reduces to:

$$y = (m - \overline{p}) + x, \tag{8}$$

for $p \geq \text{mc}$, where mc is marginal cost. In this framework output is entirely demand determined up to the point where $p = \text{mc}$. This case corresponds to the case where the aggregate supply curve is horizontal and output is independent of the real wage path up to the point where $p = \text{mc}$, as illustrated in Fig. 4.

The labor demand curve is vertical up to the point A in Fig. 4 and employment is demand determined. The labor demand curve becomes downward sloping when real wages exceed the point A because from that point, marginal costs exceed prices and producers will respond by lowering output until the marginal

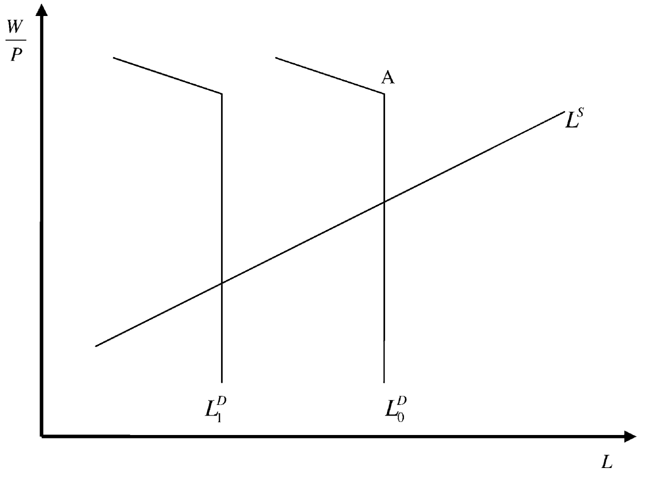

Fig. 4. Labour Market Under Price Stickiness.

conditions are satisfied. Below the point A, employment, and therefore output, is independent of real wages and lower nominal wages will not help clear markets. A negative demand shock shifts the labor demand schedule to the left and results in a reduction in real wages. If labor is on its supply schedule, real wages are pro-cyclical. If not, then the cyclicality of real wages is undetermined.

4.3. Some Degree of Both Wage and Price Stickiness

In the intermediate case nominal wage and price stickiness coexist. Consider Fig. 5, where the wage-setting curve represents Eq. (4) and the labor demand curve represents the price setting model as given by Eq. (3). Unemployment is given by the horizontal distance between W^S and the intersection between L^D and L^S, where L^S is labor supply.

Suppose that an adverse nominal demand shock shifts the wage-setting curve to the left from W_0^S to W_1^S, mainly because nominal wages are sticky. The labor demand curve shifts to the left by a magnitude that is determined by the cyclicality of the elasticity of demand, strategic interaction, the sensitivity of bankruptcies to demand, and other factors (Lindbeck & Snower, 1994). The direction of changes in real wages cannot be determined a priori. Therefore, real wages are either counter-cyclical or pro-cyclical; however, the cyclicality of real wages is muted compared to the extreme cases of only price rigidity or wage rigidity.

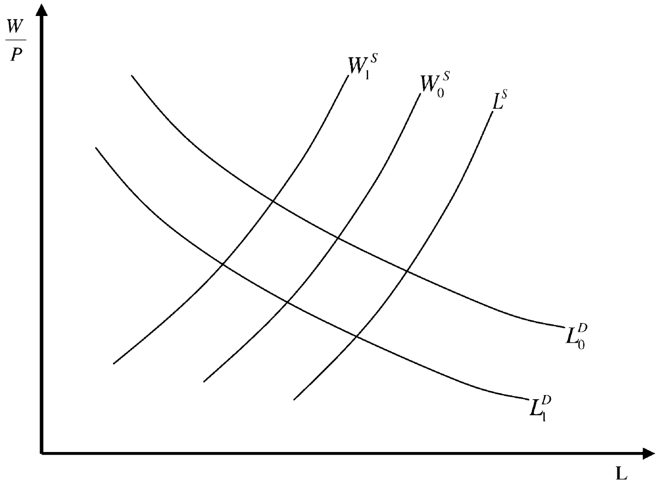

Fig. 5. Labour Market Under Imperfections in Goods and Labour Markets.

5. THE NEXUS BETWEEN OUTPUT, PRICES AND WAGES

This section tests the role of real wages for output and whether the identifying assumption of perfect competition in the goods market can be approximately maintained during the Depression. In the case of sticky wages but flexible prices it was shown in the previous section that output was a negative function of real wages and given by Eq. (3) for $\theta = 0$.

Following B&C, the output equation is estimated using annual data for country i at time t using the stochastic specification as follows:

$$y_{it} = \beta_0 + \beta_1 y_{i,t-1} + \beta_2 w_{it} + \beta_3 p_{it} + \beta_4 Str_{it} + \beta_5 Panic_{it} + \mathrm{TD}'\xi + \mathrm{CD}'\zeta + \varepsilon_{1,it}, \quad (9)$$

where *Str* is the log of the number of working days lost in strikes and lockouts, *Panic* is a binary dummy variable taking the value of one in periods of panics and zero otherwise, as classified by Bernanke and James (1991), TD is a $N(T-2)$ matrix of time-dummies, CD is a $(N-1)T$ matrix of fixed effect country dummies, ξ and ζ are vectors of fixed coefficients, where N is the number of countries and T is the estimation period, and ε is a zero-mean, independent, and identically distributed error term.[11] Strikes, Panic dummies, and time-dummies are included in Eq. (9) following B&C. As discussed by Bernanke and James (1991), the banking panics hindered the functioning of intermediation and increased the effective cost of capital. The time-dummies capture omitted time-effects that are common across countries. They may help to identify the supply function, but may also reveal a source of supply failure that is different from wage rigidity, as discussed below.

5.1. Econometric Issues

Equation (9) is estimated using non-linear generalised least squares to allow for first-order serial correlation in the residuals and the serial correlation coefficient is restricted to be the same across countries following B&C. The inverse of the estimated variances across countries are used as weights to allow for cross-country heterogeneity. Both the within (fixed effect) and the first difference estimators are used in the estimates of Eq. (9) for several reasons as given in the Appendix.

Equation (9) is identified using exogenous demand shift factors under floating and fixed exchange rates as instruments. Two sets of instruments are used. Instrument set I is identical to the one used by B&C (*str* and *Panic*, lagged nominal wages and output plus *M*1 for off-gold countries and domestic discount rates, import prices for countries on gold, fixed effect dummies and time-dummies). Instrument set II contains the domestic stock of currency in circulation, which is used as instruments in off-gold standard periods, the world nominal short-term interest rate and export price competitiveness in on-gold standard periods, *str*, *Panic*, lagged output, fixed effect dummies and time-dummies. The world short-term interest rate is measured as a 3-month Treasury bill rate and is weighted by GDP in common currency in 1929, excluding the home country. Export price competitiveness is measured as a multilateral index where third country penetrations into the export markets are taken into account. Hence, the fact that U.S. producers compete with producers from other countries in, for example, the German market is taken into account in this competitiveness measure.[12] All instruments enter contemporaneously and are lagged one period in all first stage regressions.

There are two potentially serious problems associated with the use of instruments. First, demand shifters will not solve the errors-in-variables problem to the extent that the measurement errors are correlated with the exogenous demand shifters. Second, weak instruments will lead to inconsistent estimates and to a finite-sample bias that approaches that of OLS estimates (Bound et al., 1995; Hahn & Hausman, 2002). IV estimators are particularly biased in small samples (Donald & Newey, 2001).

Various approaches are taken to deal with these issues. First, the estimates of the output equations are complemented with estimates using the limited information maximum likelihood (LIML) estimator to check the seriousness of the small sample bias following the recommendation of Donald and Newey (2001). Second, Sargan's overidentifying restrictions test is undertaken to test whether the moment conditions are correct, that is, whether the instruments are valid (Verbeek, 2000). Third, following the recommendations of Bound, Jaeger and Baker (1995) first-stage F-statistics were undertaken for all equations. Bound, Jaeger and Baker (1995) show analytically that IV estimates are severely biased as the F-statistics in the first-stage regression approach 1 from above. However, since the F-statistics for overall significance of the excluded instruments in the first-stage regressions were significant at the 1% level, they are not shown in the estimates below.

5.2. Summary Statistics

When examining the source of supply failure using regression techniques it is necessary to have identifying variations in the data. If not, then regression analysis may not reveal the source of supply failure because the coefficients may be biased towards zero. Suppose, for instance, that nominal wages are rigid and therefore show very little variation. From regression analysis one could conclude that wages are flexible because the variations in wages in the output and wage equations are too low for identification of the coefficients. The same argument applies for prices.

The summary statistics in Table 2 suggest that the key variables, namely wages, prices, unemployment and production, all show sufficiently high variation for identifying purposes. All variables in the table are measured in percentage changes except the rate of unemployment, which is measured in first differences. Wages and the value-added price deflators have about the same variance, which is about half the variance of wholesale prices due to the heavy weight of commodity prices and prices of traded products in wholesale prices.

Two sets of unemployment data are used, as discussed in detail in Section 6. One set is chiefly based on union statistics and is used by B&C (U^{bc}). The other set is mainly based on economy-wide estimates for individual countries and is referred to as U^{low}. Both sets show a large variation, especially U^{bc}, which varies substantially from year to year and shows quite extreme maximum and minimum values.

Industrial production has the highest variance of the price and output series, and is more than three times as large as the variance in the manufacturing value-added price deflator. This suggests that the manufacturing industry predominantly changed quantity and not prices in response to demand shocks and hence that price stickiness prevailed, although it does not reveal the extent of the price rigidity. By contrast, the variance in the economy-wide GDP is only about one and a half times the variance in the economy-wide value-added price deflator, which suggests that price-rigidity was much less widespread in the non-manufacturing sectors.

Table 2. Summary Statistics in Percentage Changes.

Variable	Mean	Var.	Min.	Max.
$N = 22$				
Industrial production	1.31	1.27	−28.0	30.6
Wholesale prices	−3.06	0.62	−23.0	15.4
Manufacturing wages	−0.75	0.21	−16.8	16.0
Unemployment (U^{bc})	1.22	40.0	−15.7	21.5
$N = 12$				
Industrial production	1.19	1.10	−29.0	20.3
Wholesale prices	−2.41	0.63	−21.2	15.4
Manufacturing wages	−0.87	0.34	−15.0	18.6
Man. value-added price deflator	−2.02	0.33	−20.8	14.4
Unemployment (U^{low})	0.33	7.59	−6.5	9.3
Unemployment (U^{bc})	0.50	21.9	−15.7	13.8
$N = 8$				
Economy-wide GDP	1.02	0.40	−14.7	13.0
Hourly compensation	−0.24	0.43	−24.7	11.8
Value-added price deflator	−2.07	0.25	−12.6	10.8
Unemployment (U^{low})	0.50	7.26	−6.5	7.6

Notes: Sample period: 1929–1936. All variables are measured as log first differences and multiplied by 100, except the rate of unemployment, which is measured in first differences. $N = 22$ is the country sample used by B&C, $N = 12$ is the sample of countries for which the manufacturing value-added price deflator is available (see Fig. 1), and $N = 8$ is the countries for which the economy-wide compensation to employees and the value-added price deflator are both available.

5.3. Estimation Results

The results of estimating restricted and unrestricted versions of Eq. (9) are presented in Table 3. The estimated coefficients of panics, strikes, fixed effect dummies, constants and time-dummies are not shown in the table to preserve space. Rows 1 and 16 replicate the estimates of B&C using the same data, instruments, data period, and countries (henceforth referred to as the B&C baseline model).[13] The estimates are remarkably similar to the estimates of B&C and suggest that real wages played a potentially important role during the Depression. The question is how robust the B&C results are to changes in data, specification, estimation period, and instrument set.

Rows 3 and 18 show the B&C estimates with the only difference from the B&C baseline regressions being that wages for six countries show a stronger decline over the period from 1929 to 1933 than the series used by B&C. It is, however, not obvious which wage data are of the highest quality and are most representative for manufacturing hourly earnings. The absolute value of the estimated coefficients

Table 3. Estimates of Output Equations.

	y_{t-1}	w_t	p_t	$\chi^2(6)$	$\chi^2(1)$
Levels					
1931–1936					
$N = 22$, IV, WPI	0.51(8.83)	−0.71(3.95)	0.65(5.21)	13.07	0.20
$N = 22$, WPI	0.55(8.56)	−0.30(2.49)	0.35(4.31)	12.25	0.13
$N = 22$, IV, WPI[a]	0.55(9.37)	−0.29(1.82)	0.52(4.00)	15.66	3.04
$N = 22$, IV, WPI, -TD	0.63(11.3)	−1.68(7.48)	0.65(3.63)	12.58	42.7
$N = 12$, IV, WPI	0.50(5.51)	−0.74(2.24)	0.67(2.71)	9.53	0.05
$N = 12$, IV, WPI[b]	0.61(5.93)	−1.24(2.89)	0.72(2.83)	6.76	1.71
$N = 12$, IV, PMAN	0.46(5.01)	−0.44(1.23)	0.25(1.22)	18.03	0.32
$N = 12$, IV, PMAN[b]	0.65(6.51)	−0.59(1.38)	0.12(0.56)	8.82	1.55
$N = 22$, LIML, WPI	0.70(6.36)	−0.86(3.91)	0.67(3.35)	5.99	1.58
$N = 12$, LIML, PMAN[b]	0.67(4.79)	0.02(0.00)	0.15(0.98)	8.85	0.02
$N = 8$, IV[b]	0.55(6.07)	−0.06(0.51)	0.84(7.61)	9.55	34.4
1927–1936					
$N = 22$, IV, WPI	0.76(18.7)	0.12(0.68)	0.01(0.29)	10.29	0.61
$N = 12$, IV, WPI[b]	0.82(13.5)	−0.29(3.36)	0.05(0.44)	11.25	2.50
$N = 12$, IV, PMAN[b]	0.83(13.9)	−0.27(2.11)	0.00(0.12)	11.99	4.77
$N = 8$, IV[b]	0.67(7.66)	−0.07(0.93)	0.59(4.10)	9.55	14.3
First differences					
1933–1936					
$N = 22$, IV, WPI	−0.14(0.82)	−0.74(3.95)	0.79(2.41)	10.02	0.03
$N = 22$, WPI	−0.11(0.78)	−0.39(2.56)	0.12(1.39)	11.33	2.76
$N = 22$, IV, WPI[a]	−0.12(0.73)	−0.11(0.27)	0.42(1.26)	9.91	1.07
$N = 22$, IV, WPI, -TD	0.00(0.04)	−0.51(1.37)	0.78(2.35)	9.77	1.03
$N = 22$, LIML, WPI	0.31(1.72)	−0.58(1.76)	0.30(1.07)	5.62	2.50
$N = 12$, IV, WPI	0.38(1.58)	−0.16(1.15)	0.28(1.75)	12.69	0.02
$N = 12$, IV, WPI[b]	−0.02(0.13)	−0.99(2.60)	0.70(2.30)	15.82	0.17
$N = 12$, IV, PMAN	0.41(1.89)	0.07(0.10)	0.01(0.04)	12.89	0.02
$N = 12$, IV, PMAN[b]	0.01(0.05)	−0.96(2.47)	−0.31(0.74)	12.28	5.45
$N = 12$, LIML, PMAN[b]	0.08(0.35)	−0.26(0.95)	−0.10(0.25)	12.32	1.43
$N = 8$, IV[b]	0.51(3.80)	−1.20(3.50)	1.09(3.31)	9.55	0.20
1929–1936					
$N = 22$, IV, WPI	0.86(3.81)	−0.09(0.21)	0.82(4.24)	11.04	6.97
$N = 12$, IV, PMAN[b]	0.25(2.72)	1.40(3.56)	−0.28(0.81)	15.80	9.88
$N = 8$, IV[b]	0.17(1.09)	0.24(0.86)	0.49(1.31)	10.01	6.62

Notes: The numbers in parentheses are absolute *t*-statistics. Panics, strikes, constants, fixed effect dummies (in level estimates) and time-dummies are included in all estimates but are not shown. $N = 22$ is the 22 countries included in the estimates by B&C. $N = 12$ is the 12 countries for which manufacturing prices are available, and include the countries listed the notes to Fig. 1. $N = 8$ is the 8 countries for which economy-wide value-added price deflators and total labor costs are available, and include the countries listed the notes to Fig. 1. -TD signifies that time-dummies are excluded from the regression equations. The instruments used by B&C are used. IV = instrumental estimator. LIML = limited information maximisation likelihood estimator. PMAN = prices measured by value-added price deflator. WPI = prices are measured by wholesale prices. $\chi^2(6)$ = Wald test for identifying restrictions, and is distributed as $\chi^2(6)$ under the null hypothesis of instrument validity. $\chi^2(1)$ = Wald test for the same coefficient of wages and prices and with opposite sign, and is distributed as $\chi^2(1)$ under the null hypothesis of equality and opposite sign.

[a] Alternative wage data for six countries as explained in the Data Appendix.

[b] Instrument variable set II: Domestic stock of currency in circulation in the off-gold standard periods. The world nominal short-term interest rate and export price competitiveness are used as instruments in on-gold standard periods. One-period lags of dependent variables are included for all countries over the whole period.

of wages is reduced substantially in the level estimates and is rendered statistically insignificant in the first-difference estimates, which suggests that the B&C results are sensitive to the choice of wage data.

Excluding the time-dummies from the B&C base-line regressions renders the estimated coefficient of real wages substantially more negative in the level estimates and the hypothesis that $\beta_2 = -\beta_3$ is rejected at any conventional significance level (row 4). In the first-difference estimates the estimated coefficients of wages is statistically insignificant (row 19). These results suggest that the time-dummies play an important role in the regressions and capture omitted variable effects. Since the time-dummies capture a common time-profile of the Depression among countries in the B&C baseline regressions, these results suggest that the B&C results are mainly driven by between country effects (cross-country variations) as opposed to within country effects. The estimated coefficients of the time-dummies were particularly significant in the level estimates in row 1: −0.136(11.98) in 1931, −0.183(5.64) in 1932, −0.095(3.15) in 1933, −0.045(3.35) in 1934, and −0.040(3.49) in 1935, where the numbers in parentheses are absolute *t*-statistics. The time-dummies therefore account for a 5% decline in production from 1931 to 1932, a 9% increase in production from 1932 to 1933, and a further 5% increase in production from 1933 to 1934.

Extending the estimation period back four years to 1927 for the level estimates and 1929 for the difference estimates alters the estimation results substantially.[14] The estimated coefficients of wages and prices are statistically and economically insignificant in the level estimates (row 12). In the first-difference estimates the estimated coefficient of wages is statistically insignificant but the estimated coefficient of prices remains significant and positive (row 27). This result is perhaps not surprising given that the real wage increase from 1927 to 1929, as seen from Fig. 1, coincided with a cyclical upturn. The result is consistent with Silver and Sumner's (1995) finding of counter-cyclical real wages over the period from 1930 to 1939 for the U.S. using wholesale prices as deflators.

The results from the longer estimation period raise two concerns. First, the B&C results are predominantly driven by the recovery phase although their focus is on the downturn, especially in their first-difference estimates, which only cover the recovery period from 1933 to 1936. Second, the coefficient estimates are highly sensitive to estimation period, which suggests that their estimates are either subject to an omitted variable or small sample bias. Under the alternative hypothesis of price rigidity, the omitted variable is mark-ups. Consistent estimates could be obtained from IV estimates if the instruments for wages are uncorrelated with mark-ups. However, it is difficult to find instruments that are uncorrelated with mark-ups and the coefficient of wages will consequently be biased under the alternative hypothesis of price rigidity.

The LIML estimates in rows 9 and 20 are very close to the IV estimates in rows 1 and 16 and are consistent with the high significance of the *F*-tests for overall significance in the first stage regressions, and the tests for over-identifying restrictions in Table 3. The instrument validity tests are insignificant, except the estimates in row 7, which are marginally significant at the 1% level. These results indicate that the instruments have adequately dealt with the simultaneity and the errors-in-variables problem.

Regressing the B&C baseline model for the 12 countries for which the manufacturing value-added price deflator is available does not alter the B&C results much (rows 5 and 21), except that the absolute value of the estimated coefficient of wages is reduced in the first difference estimates. Furthermore, using the alternative instrument gives very significant coefficient estimates of the coefficients of prices and wages (rows 6 and 22). These results suggest that the B&C results are not significantly affected by the country sample and the choice of instrument set.

Using the value-added price deflator instead of wholesale prices alters the results substantially. For both manufacturing and the whole economy, the estimated coefficients of prices and wages are mainly insignificant regardless of instrument set, estimator, sectoral coverage, and estimation period (rows 7, 8, 11, 14, 23, 24, 25, 28 and 29). The sticky wage hypothesis is only supported by the economy-wide first-difference estimates in the recovery phase from 1933 to 1936 (row 26), for which the estimated coefficients of wages and prices have the right sign, and are significant, and the hypothesis that the estimated coefficients of wages and prices are the same and of opposite sign cannot be rejected at conventional significance levels. However, this result is not sufficient evidence for the sticky wage hypothesis given that the result changes significantly for changes in estimation method, estimation period, and sectoral coverage, and particularly when it is taken into account that these results only apply for the upturn phase.

To investigate whether the estimates where prices are measured by the value-added price deflators, are biased due to errors-in-variables, the within and the first-difference estimates are combined to give consistent estimates using Eq. (A2) in the Appendix (corresponding to combining the estimates in rows 8 and 24 for manufacturing and rows 11 and 26 for the whole economy).[15] In these models output is regressed on real wages and the deterministic variables since Eq. (A2) applies only for one stochastic regressor. The recovered coefficients of real wages are -0.29 and -0.22 for manufacturing and the whole economy, respectively, and are slightly lower in absolute terms if the longer estimation period is used. Using these estimated elasticities suggests that the approximately 10% real wage increase from 1929 to 1932 accounts for less than a 3% decline in output over the same period and therefore that real wages could not have been entirely responsible for the supply failure.

These results are consistent with the results of three important other studies. For the U.K. Dimsdale, Nickell and Horsewood (1989) estimate labor demand in the interwar period and find that real product wages are insignificant but that cyclical demand is significant, where cyclical demand is used as a proxy for cyclical mark-ups. From labor demand estimates for 14 industrialized and semi-industrialized countries for the interwar period, Newell and Symons (1988) find that the estimated coefficients of real product wages are of either low significance or are insignificant. Clearly price stickiness must played a role if the labor demand schedule could not easily be identified. Similarly Bernanke and James (1991) regress the growth in industrial production on the growth in nominal wages and wholesale prices, among other variables, over the period from 1930 to 1936 using the ordinary least squares pooled estimator. Their estimated coefficients of nominal wages are statistically insignificant at any conventional significance level. This result is consistent with the OLS estimates in Table 3 where the estimated coefficient of nominal wages is insignificant in the first-difference OLS estimates over the period from 1929 to 1936 (row 27), which is similar to the estimation period used by Bernanke and James (1991).

Overall the results in this section suggest that the results of B&C are sensitive to estimation period, instruments, measurement of wages and prices, model specification, and whether time-dummies are included in the estimates. The sensitivity of the results to estimation period is particularly serious because it does suggest that B&C's baseline regressions are subject to omitted variables and measurement errors. In their estimates they omit the first crucial years of the Depression and miss out the decline almost completely in the first-difference estimates by starting in 1933. Combined with the fact that the time-dummies explain a large fraction of the time-profile of the Depression, this suggests that their results hinge very strongly on cross-country variations in the upturn.

The results in this section, however, do not necessarily imply that real wages were unimportant during the Depression. The message of the results in this section is that the supply schedule has not been identified. The model in this section only identifies the supply schedule if prices are flexible, because the equations have been derived under the assumption of perfect competition in the goods market. The question here is therefore not whether the coefficients of real wages are significantly negative. If wages are rigid but prices flexible, then demand shocks will materialise in movements along the labor demand schedule, and the supply schedule is clearly identified and the coefficients of wages will be negative. If prices are sticky, however, nominal demand shocks will result in shifts in both the wage setting and the labor demand schedules, and the real wage-supply nexus becomes blurred, as is evident from Fig. 5. The supply schedule is consequently not identified. Furthermore, under imperfect competition, the causal link from prices to output is broken and firms determine output and prices simultaneously. The estimates in this section are therefore not an exercise in the importance of real wages on output but whether the hypothesis of full price flexibility can be maintained.

Incorporation of mark-ups into the output equation should, in principle, enable identification of the source of supply failure. Unfortunately, the data requirements are too high for marginal costs to be estimated using the methods of Hall (1988) and Roeger (1995) for the interwar period. A simpler, and probably much more robust way of identifying sources of supply failure is to estimate wage and price equations separately and from these equations infer the sources of supply failure. This is done in the next three sections.

6. WAGE STICKINESS DURING THE DEPRESSION

To test for the degree and the potential source of wage rigidity, the following equation, which nests the Phillips and the wage curves, is estimated over the period from 1927 to 1937:

$$\Delta w_{it} = \varsigma_0 + \varsigma_1 \Delta w_{i,t-1} + \varsigma_2 \Delta p_{it} + \varsigma_3 U_{it} + \varsigma_4 \Delta U_{it} + \varsigma_5 \Delta \mathrm{pr}_{it} + \mathrm{CD}'\upsilon + \varepsilon_{2,it}, \tag{10}$$

where U is the rate of unemployment measured in decimal points, and pr is the log of labor productivity, which is measured as real GDP divided by hours worked, but is only included in the economy-wide estimates since manufacturing data are not available for some countries.[16] Log level estimates are not undertaken because no allowance for Phillips curve effects can be made in level estimates and, more seriously, because the residuals exhibited serious first-order serial correlation, which did not disappear when using the non-linear estimator to correct for first-order serial correlation. The effects of the level and the change in unemployment on wage growth is again referred to as the Phillips curve effect and the wage curve effect, respectively.

To gain efficiency and to minimise the small sample bias that is associated with the instrumental variable method, the estimation period starts approximately two years before the onset of the Depression and terminates one year after the estimates in the previous section. To gain further efficiency, the generalised instrumental variable method, where the covariance matrix is weighted by the correlation of the disturbance terms between countries, is used for the economy-wide estimates.[17] This estimator is not used for manufacturing, where $N = 12$, because the generalised instrumental variable estimator is only feasible for $T > N$. Direct taxes, indirect taxes, and the ratio of import prices and the value-added price deflator, strikes and the panic dummies were initially included in the estimates for both manufacturing and for the whole economy, but were insignificant, which suggests that supply shocks were not sufficiently important during the Depression to be identified by the estimates.

Prices are measured by the value-added price deflator and for comparison with the B&C estimates, also by wholesale prices. Modern versions of wage determination stress that both consumer prices and the value-added price deflator are relevant for wages because value-added price deflators are the important deflators for firms and consumer prices are the relevant deflators for workers (see Madsen, 1998). To allow for the possibility that both the value-added price deflator and consumer prices influenced wages, the log of the ratio between consumer prices and the value-added price deflator or wholesale prices was included as an additional regressor in Eq. (10). However, the estimated coefficient of the ratio was insignificant at the 5-percentage level in all estimates, suggesting that wages were not indexed to consumer prices but to the value-added price deflator.

The stochastic regressors, except the lagged dependent variable, are instrumented using instrument set II (*Str*, *Panic*, the domestic stock of currency in circulation in off-gold standard periods, the world nominal short-term interest rate and export price competitiveness in on-gold standard periods, time-dummies, lagged dependent variable and two-period lags of the dependent variables as an instrument for the lagged dependent variable). An exception is in the estimates of the model where the sample of B&C is used ($N = 22$), for which instrument set I is used (*str* and *Panic*, lagged nominal wages and output plus $M1$ for countries off gold and domestic discount rates, import prices for countries on gold, time-dummies and two-period lags of the dependent variables as an instrument for the lagged dependent variable). The lagged dependent variable is instrumented using two-period lags of the dependent variable.

Two sets of unemployment data, which are derived under two different sets of principles, are used in the estimates. One set is similar to the data used by B&C (U^{bc}). The data are mainly from Galenson and Zellner (1957) and are based on trade union statistics. For countries for which unemployment statistics are not available, simulated unemployment rates are constructed using a method suggested by B&C. Namely, the rate of unemployment is regressed on manufacturing employment for the countries for which both series are available. The coefficient estimates are then used to simulate unemployment for the countries where manufacturing employment, but not unemployment, is available. The other set of unemployment data, U^{low}, takes into account that the trade union records only cover a fraction of the labor force and often only include males (Grytten, 1995, p. 231). These unemployment estimates are substantially lower than the estimates reported by Galenson and Zellner. The source of unemployment data for each individual country is detailed in the Data Appendix.

The country dummies in Eq. (10) do not have their usual interpretation of fixed effects dummies because the fixed effects have been removed by the first-difference transformation, but are included for an econometric and an economic reason. The econometric reason is that the country dummies remove the bias due to the possibility that the level of unemployment is measured with error. The economic reason is that it is the deviation of unemployment from its natural rate, and not the level of unemployment, that puts downward pressure on wage growth according to the natural rate hypothesis. Under the assumption that the "natural rate" of unemployment is constant but varies across countries, the country dummies will capture cross-country variations in the natural rate.

No assumptions are made about the generation of price expectations in the estimates and the instrumental variable method certifies that the measurement error contained in actual prices as a measure of price expectations does not render the coefficient estimates inconsistent and biased. Lagged prices were initially included in the estimates to allow for slow adjustment of wages to innovations in prices but were statistically insignificant at the 5% level in all estimates. This suggests that instrumented contemporaneous prices best reflect expected prices. Furthermore, following Dimsdale, Nickell and Horsewood (1989), first differences of price changes were initially included in the estimates as proxies for inflation expectational errors under the assumption of extrapolative expectations. However, the estimated coefficient was significantly positive in all estimates. It cannot be excluded that this result reflects that accelerating inflation leads to workers intensifying their wage demands. However, the variable was deleted without affecting the estimates for the sake of simplification.

The results of estimating restricted and unrestricted versions of Eq. (10) are presented in the upper half of Table 4. The instrument validation tests do not give evidence against the instruments. The estimated coefficients of the level of unemployment are consistently significant and negative, particularly in the economy-wide estimates, which suggests a strong Phillips curve effect. The estimated coefficients of the level of unemployment are generally higher when unemployment is measured by U^{low} than by U^{bc}. The ratio of the coefficient estimates of U^{bc} and U^{low}, however, approximately equals the ratio between the average values of U^{low} and U^{bc}. Hence, the effects on wage growth of the level and change in unemployment are approximately the same regardless of whether U^{low} or U^{bc} is used as the regressor.

Turning to the estimated coefficients of the change in unemployment, the estimates suggest that the persistence of shocks on wages, and hence on unemployment, differs across sectors. The sign of the estimated coefficients of the

Table 4. Parameter Estimates of Philips Curves and Price Equations.

	Phillips Curve						
	Δw_{t-1}	U_t	ΔU_t	Δp_t	$\Delta \mathrm{pr}_t$	$\chi^2(6)$	
$N = 22$, WPI, U^{bc}	−0.10(1.46)	−0.20(3.27)	−0.39(2.34)	0.18(2.31)		7.1	
$N = 12$, PMAN, U^{bc}	0.20(2.13)	−0.14(2.27)	−0.36(3.11)	0.36(3.90)		14.14	
$N = 12$, PMAN, U^{low}	0.19(2.04)	−0.27(2.79)	−0.61(3.69)	0.40(3.52)		14.03	
$N = 12$, PMAN, U^{bc}, LIML	0.15(1.50)	−0.15(1.91)	−0.21(1.75)	0.39(5.15)		5.34	
$N = 12$, PMAN, U^{low}, LIML	0.13(1.42)	−0.28(2.23)	−0.31(1.55)	0.40(5.25)		6.02	
$N = 12$, WPI, U^{bc}	0.25(2.63)	−0.18(2.68)	−0.26(1.92)	0.13(2.26)		14.14	
$N = 12$, WPI, U^{low}	0.23(2.57)	−0.33(3.26)	−0.47(2.40)	0.15(2.84)		16.07	
$N = 8$, U^{bc}, GIVE	0.01(4.59)	−0.18(5.75)	0.21(1.82)	0.84(7.81)	0.87(18.1)	5.22	
$N = 8$, U^{low}, GIVE	0.02(7.01)	−0.43(12.6)	0.20(1.35)	0.77(10.5)	0.90(18.5)	4.02	
$N = 8$, U^{bc}, LIML	0.01(1.35)	−0.20(4.76)	0.31(3.26)	0.93(10.4)	0.88(8.80)	10.24	
$N = 8$, U^{low}, LIML	0.01(0.91)	−0.40(4.25)	0.43(2.36)	0.87(8.09)	0.86(9.14)	11.12	
	Price Equation						
	Δp_{t-1}	Δw_t	Δp_t^c	Δp_t^{im}	Δy_t	Δy_t^c	$\chi^2(4)$
$N = 12$, WPI	−0.03(0.62)	0.14(1.24)	0.48(6.09)	0.31(7.26)	−0.03(0.60)	−0.05(2.26)	3.48
$N = 12$, PMAN	0.19(2.01)	0.30(2.96)			0.05(1.50)	−0.02(1.20)	2.76
		Δp_{t-1}	Δw_t	Δy_t	Δy_t^c	$\Delta \mathrm{pr}_t$	$\chi^2(5)$
$N = 8$, GIVE		0.07(0.71)	0.54(4.55)	0.39(4.99)	−0.02(1.07)	−0.47(2.54)	11.48
	Δp_{t-1}	Δw_t	Δp_t^c	Δp_t^{im}	U_t	ΔU_t	$\chi^2(4)$
$N = 12$, WPI, U^{bc}	−0.05	0.07(0.63)	0.52(8.35)	0.31(7.07)	0.05(0.23)	−0.07(0.56)	7.07
		Δp_{t-1}	Δw_t	U_t	ΔU_t	$\Delta \mathrm{pr}_t$	$\chi^2(4)$

$N = 12$, PMAN, U^{bc}	0.17(1.79)	0.24(2.74)	−0.01(0.27)	−0.45(2.49)		4.29
$N = 12$, PMAN, U^{low}	0.17(1.84)	0.24(2.84)	−0.01(0.18)	−0.39(2.61)		4.19
$N = 8$, U^{bc}, GIVE	0.12(1.93)	0.53(6.13)	0.00(0.21)	−0.49(6.88)	−0.33(2.57)	11.22
$N = 8$, U^{low}, GIVE	0.14(1.91)	0.58(5.62)	0.03(0.22)	−0.83(5.37)	−0.33(1.87)	10.59
$N = 8$, U^{bc}, LIML	0.10(1.43)	0.65(8.45)	0.15(3.40)	−0.44(6.38)	−0.56(4.87)	9.22
$N = 8$, U^{low}, LIML	0.15(1.85)	0.63(7.59)	0.28(2.89)	−0.78(5.57)	−0.53(4.41)	8.55

Notes: See notes to Table 3. GIVE = generalised instrumental variables estimator. $\chi^2(i)$ = Wald test of overidentifying restrictions, and is distributed as $\chi^2(i)$ with i degrees of freedom. The unemployment rate is measured in decimal points. Constants and fixed effect dummies are included in all estimates (fixed effect dummies are included in first-difference estimates of the Phillips curve but not the price equation) but are not shown. Instrument set I is used in the $N = 22$ estimates, and the instrument set II is used for the other estimates (see text). U^{bc} = unemployment data used by B&C. U^{low} = unemployment rates based on estimations for individual countries. Estimation period 1927 to 1937.

change in unemployment is consistently positive in the economy-wide estimates and therefore stands in sharp contrast to the predictions of wage equation based models, where only changes in unemployment are assumed to influence wage growth, and negatively. Coupled with the fact that the estimated coefficient of the level of unemployment is significantly negative, this result suggests that unemployment adjusts rapidly to shocks in the whole economy. A larger degree of persistence to shocks prevails in manufacturing where the estimated coefficients of the change in unemployment are consistently negative, although with varying degrees of statistical significance.

The discrepancy in wage behavior between sectors is also evident from the parameter estimates of wage adjustment to innovations in prices. Wages adjust about 40% to price innovations within the first year in manufacturing using the value-added price deflator as the price variable (rows 2–5). Allowing for the effects of lagged wages, simulations of the models indicate that manufacturing wages decreased, on average, by approximately 6% over the period from 1929 to 1932 due to the price deflation. Taking account of the approximately 2.2–2.7% wage reducing effect of the level and the change in unemployment, depending on which measure of unemployment is used, over the same period, it can be concluded that wage stickiness in manufacturing could not have been solely responsible for the supply failure during the Depression.[18]

The economy-wide estimates show a rapid adjustment of wages to innovations in prices and productivity. About 85% of the adjustment takes place within the same year. Simulations of the models indicate that the 18% decline in value-added prices and the 4% increase in productivity, on average, resulted in a 12% reduction in wages over the period from 1929 to 1932, using price and productivity elasticities of 0.85. Allowing for the approximately 3.5–4.5% wage reducing effect of the unemployment over the same period, depending of which unemployment measure is used, it can be concluded that wages were reasonably flexible on an economy-wide scale during the Depression.

When wholesale prices are used as deflators, the significance of the estimated coefficients of prices is substantially reduced as compared to the estimates where the value-added price deflator is used (rows 1, 6 and 7).[19] The estimated coefficients of wholesale prices are less than 0.2 in all the estimates and therefore point towards a large degree of nominal wage rigidity. The low estimated coefficient of wholesale prices is not surprising, however, given that commodity prices fell substantially during the first years of the Depression. Under perfect market clearing in the goods and labor markets, a reduction in commodity prices yields a positive output response and an increase in the nominal wage that is compatible with full employment. A reduction in the value-added price deflator, by contrast, necessitates a reduction in nominal wages to maintain full employment. Since wholesale prices are composed of both commodity prices and, implicitly, the value-added price deflator, the coefficient of prices in the Phillips curve will be biased downwards, particularly in periods of highly volatile commodity prices, and therefore do not give much information about nominal wage rigidity.

How do the results compare with other studies? Surprisingly few estimates of the Phillips curve have been undertaken for the interwar period. Almost all studies of wage adjustment only allow for a wage curve effect and therefore *a priori* exclude the possibility that wages adjust to disequilibria in the labor market due to Phillips curve effects. Newell and Symons (1988) find the level of real wages to be fairly insensitive to the level of unemployment for 14 countries. Furthermore, they find a short-run price elasticity of wages of approximately 0.5. B&C estimate the short-run wholesale price elasticity of wages to be approximately 0.3 depending on model specification, which is close to the estimates in Table 4 using wholesale prices. Furthermore, they find the level of wages to be insensitive to the level of unemployment.[20] Dimsdale, Nickell and Horsewood (1989) find the level of wages to be significantly negatively related to the level of unemployment for the U.K.

7. PRICE STICKINESS DURING THE DEPRESSION

To investigate the degree of price stickiness, the following stochastic specifications of the price equation, which was derived in Section 4, are estimated:

$$\Delta p_{it} = \varphi_0 + \varphi_1 \Delta p_{i,t-1} + \varphi_2 \Delta w_{it} + \varphi_3 \Delta p_{it}^{\mathrm{c}} + \varphi_4 \Delta p_{it}^{\mathrm{im}} + \varphi_5 \Delta \mathrm{pr}_{it} + \varphi_6 \Delta y_{it} + \varphi_7 y_{it}^{\mathrm{cyc}} + \mathrm{CD}'\kappa + \varepsilon_{4,it} \tag{11}$$

and

$$\Delta p_{it} = \lambda_0 + \lambda_1 \Delta p_{i,t-1} + \lambda_2 \Delta w_{it} + \lambda_3 \Delta p_{it}^{\mathrm{c}} + \lambda_4 \Delta p_{it}^{\mathrm{im}} + \lambda_5 \Delta \mathrm{pr}_{it} + \lambda_6 \Delta U_{it} + \lambda_7 U_{it} + \mathrm{CD}'\nu + \varepsilon_{5,it}, \tag{12}$$

where y^{cyc} is cyclical demand, p^{c} is commodity prices, and p^{im} is import prices. Cyclical demand is estimated as the residual from regressing income on a time trend and a squared time trend over the period from 1920 to 1939 for each individual country. The residual is then instrumented using the instruments as specified below.

Equations (11) and (12) are estimated for manufacturing using the value-added price deflator and wholesale prices and for the whole economy using the value-added price deflator. Some of the coefficients are restricted to zero as indicated in Table 4. All stochastic regressors, except the lagged dependent variables, are instrumented using instrument set II. A two-period lag of the dependent variable is used as an instrument for the lagged dependent variable. Log level estimates are not undertaken because the residuals exhibited serious serial correlation, which did not disappear using the non-linear estimator to correct for first-order serial correlation, and because they exclude the possibility of testing for output level effects. The non-linear generalised least squares estimator is used again. Commodity and import prices are only included as regressors in the estimates where wholesale prices are used as the dependent variable.

Both output and unemployment are used as demand shifters. Although only output refers to the goods market, unemployment is also used to test the sensitivity of prices to demand shocks because desired effects may not be captured by income. The problems associated with the use of cyclical income is that it is sensitive to estimates of the income trend, whereas there is no need to remove a trend from the unemployment rate. The demand shift variables are measured in both levels and first differences to allow for the possibility that prices are sensitive to both the changes and the cyclical level of demand. A cyclical decline in demand may be perceived by firms to be temporary and they will consequently not alter prices. If demand remains depressed, it is possible that firms will start lowering their prices until the goods market has been cleared using the philosophy of the Phillips curve.

The results of estimating restricted and unrestricted versions of Eqs (11) and (12) are shown in the lower part of Table 4. The instrument validity tests do not give evidence against the chosen instruments. The estimates in rows 13, 16 and 17 show that the manufacturing value-added price deflator is fairly insensitive to wage changes, with estimated short-run wage elasticities of approximately 0.25, but it is somewhat responsive to changes in unemployment. The estimated coefficients of cyclical demand, the change in output and the level of unemployment, however, were insignificant at any conventional significance level. Simulations of the models with unemployment as demand shift variables (rows 16 and 17) show that the 8–14 percentage point increase in the rate of unemployment from 1929 to 1932, depending on which measure of unemployment is used, resulted in a 3–6% reduction in manufacturing prices.

The parameter estimates of the economy-wide price equations displayed in rows 14 and 18–21 show that that prices are quite sensitive to innovations in both demand and wages. Both the estimated coefficients of changes in output and changes in unemployment are statistically highly significant, which, unlike manufacturing, suggests that the estimates are robust to choice of the demand shift factor. Simulations of the models show that the 12.6% decline in real GNP, on average, contributed to a 5% decline in the value-added price deflator over the period from 1929 to 1932. An approximately 7% reduction in prices is predicted if the change in unemployment is used as the demand shifter, regardless of which measure of unemployment is used. This suggests that there is a robust positive relationship between changes in prices on an economy-wide scale and changes in demand.

The estimated coefficient of wages is 0.54 when income is used as the demand shift variable (row 14) and about 0.6 when unemployment is used, regardless of which measure of unemployment is used (rows 18–21). These results suggest that the wage elasticities are somewhat insensitive to the choice of demand shift variable. Non-nested tests and Akaike's information criterion are used to discriminate between the models. Both criteria favor the models using unemployment as demand shifters.[21] Hence, the model with unemployment will be used as the benchmark model in the simulations in the next section.

The estimated coefficients of productivity are statistically and economically significant in the economy-wide estimates, especially in the LIML estimates, and are in the range of 0.33 and 0.56. Hence, prices are less responsive to productivity advances than wages. This result is consistent with the coefficient estimates of the other variables in the models, which showed that wages are more responsive to price innovations than prices are to wage innovations and that unemployment, in excess of its natural rate, puts persistent downward pressure on wages, whereas changes in unemployment only have one-off effects on prices.

The estimates for manufacturing where wholesale prices are used as the dependent variable (rows 12 and 15) show, perhaps, some surprising results. First, wholesale prices are not sensitive to Δy, ΔU and U, and move counter to y^{cyc}. In other words, movements in wholesale prices were more counter-cyclical than pro-cyclical. This result is remarkable because it shows that the decline in wholesale prices during the first years of the Depression was not a cyclical response, as is often stressed in macroeconomic textbooks. Second, wholesale prices are completely insensitive to wages. Third, wholesale prices are almost entirely driven by import and commodity prices, which reinforces the discussion in Section 2 that import and commodity prices had a heavy weight in wholesale prices and therefore that wholesale prices were misleading indicators of the value-added price deflator. Overall, these results show that the decline in wholesale prices at the onset of the Depression was a result of declining commodity prices, in particular, and declining import prices, and not due to the fall in aggregate demand.

Comparing the results with the results in the literature it is remarkable how little attention has been given to estimating the degree of price flexibility. Dimsdale, Nickell and Horsewood (1989) find that prices are completely unresponsive to aggregate demand shocks, but do not test for nominal price stickiness because they restrict the coefficient of wages to one and only allow the deviation of prices from their long-run equilibrium to last for less than a year.

8. MODEL SIMULATIONS

The economy-wide estimates of the price equation and the Phillips curve, rows 8, 9, 18 and 19, are used in this section to simulate the effects of wage and price stickiness on unemployment. The restricted non-stochastic counterparts of Eqs (10) and (12) can be simplified as follows:

$$\Delta w_{it} = \gamma_0 + \gamma_1 \Delta p_{it} - \gamma_2 U_{it} + \gamma_3 \Delta \text{pr}_{it} + \text{CD}'\iota \tag{13}$$

$$\Delta p_{it} = \psi_0 + \psi_1 \Delta w_{it} - \psi_2 \Delta U_{it} - \psi_3 \Delta \text{pr}_{it}, \tag{14}$$

where coefficients with low economic and statistical significance in the estimates in the previous section have been restricted to zero to simplify the exposition. All coefficients are expected to be positive. The price equation that contains unemployment as the demand shifter is used because the model selection criteria that were used in the previous section, favored this specification. Effects from the lagged dependent variables are suppressed because they were either negligible or insignificant.

The equation system yields the following solution:

$$U_{it} = \frac{\psi_2}{\gamma_2 + \psi_2} U_{i,t-1} - \frac{(1-\gamma_1)\Delta p_{it}}{\gamma_2 + \psi_2} - \frac{(1-\psi_1)\Delta w_{it}}{\gamma_2 + \psi_2} + \frac{(\gamma_3 - \psi_3)\Delta \text{pr}_{it}}{\gamma_2 + \psi_2} + \frac{\gamma_0 + \psi_0 + \text{CD}'\iota}{\gamma_2 + \psi_2}, \tag{15}$$

which corresponds to a restricted version of Eq. (7) with the exception that unemployment is used as the scale variable for output.

Equation (15) shows how unemployment evolves over time following shocks to demand and productivity. Apart from productivity shocks, supply shocks are absent from the equation since they were insignificant in the empirical estimates in Section 6. Very similar results are obtained by Dimsdale, Nickell and Horsewood (1989), who find that the unemployment path was predominantly determined by real import prices and demand.

The natural rate is ruled out by the estimates since unemployment is non-neutral to innovations in prices, wages, and productivity in the long run. Homogeneity in wages and prices was not imposed since the hypothesis that the long-run coefficient of wages and prices were rejected at conventional significance levels.[22] Furthermore, the hypothesis of long-run productivity neutrality was strongly rejected. This need not mean that the natural rate did not exist, but that the labor and goods markets were sufficiently slow to adjust toward their long-run equilibrium to be identified by the estimates. Identification of the adjustment path was furthermore rendered difficult because goods and labor markets were constantly out of equilibrium during the Depression.

The second and third right-hand terms in Eq. (15) represent the unemployment effect of demand shocks. A demand shock that drives prices and wages down leads to increasing unemployment to the extent that wages and prices fail to adjust to price and wage changes, respectively, and this generates a wedge between actual and full employment wages and prices. This in turn leads to a change in unemployment. The fourth right-hand side term is the effects on unemployment of productivity shocks. Since the estimates in the previous sections show that wages are more responsive to productivity shocks than prices, it follows that a positive productivity shock leads to higher unemployment because producers fail to lower their prices sufficiently to a positive productivity shock, but instead increase their mark-ups. The last right-hand-side term, divided by one minus the coefficient of lagged unemployment, defines the natural rate of unemployment, that is the level of unemployment at which price and wage expectations are borne out.

Equation (15) is used to decompose the unemployment effects of the demand shocks into wage and price rigidity. One caveat of this decomposition is that unemployment effects of wage and price stickiness cannot strictly be decomposed to their source because of the interrelationship between the labor demand and the wage setting schedules. The unemployment effects of an adverse demand shock that shifts the wage setting schedule to the left due to nominal price rigidity, for instance, depends not only on the slope and the shift in the Phillips curve but also the slope of the labor demand curve. Hence, the more responsive is the goods market to demand shocks, the lower are the unemployment effects of a demand shock due to rigidities in the labor market. Similarly, the more reactive is the labor market to demand shocks the lower are the unemployment effects of the demand shocks, due to rigidities in the goods market.

In the present case where price growth is affected by the change in demand, as opposed to the level of demand, the unemployment effects of nominal wage rigidity are muted on impact (ψ_2 in Eq. (15)) but zero in the long run as seen from the long-run solution to Eq. (15):

$$U_{it} = -\frac{(1-\gamma_1)\Delta p_{it}}{\gamma_2} - \frac{(1-\psi_1)\Delta w_{it}}{\gamma_2} + \frac{(\gamma_3-\psi_3)\Delta \mathrm{pr}_{it}}{\gamma_2} + \frac{\gamma_0+\psi_0+\mathrm{CD}'\iota}{\gamma_2}.$$

Hence, in the long run the unemployment effects of wage stickiness are not muted by price flexibility because the labor demand curve is vertical. Shocks are only muted by the wage growth response to unemployment in the Phillips curve. If the Phillips-curve effect did not exist, shocks would have permanent unemployment effects. Since the decomposition in Eq. (15) cannot account for this aspect, it underestimates the increase in unemployment that is due to price stickiness and overestimates the unemployment effects of wage stickiness.[23]

Table 5. Decomposition of Unemployment Based on Simulations of Eq. (15).

	Wage Stickiness	Price Stickiness		Simulated	ΔU
	1	2	3	4	5
Rows 8 and 18 (U^{bc}) in Table 4					
1930	1.38	−0.54	2.46	3.30	5.18
1931	1.76	2.48	0.26	4.48	5.82
1932	2.86	5.05	2.06	9.96	6.58
Total	6.00	6.99	4.78	17.74	17.58
Rows 9 and 19 (U^{low}) in Table 4					
1930	1.01	−0.19	1.28	2.11	2.22
1931	1.31	1.17	0.14	2.62	2.56
1932	2.05	2.30	1.13	5.47	3.70
Total	4.37	3.28	2.55	10.20	8.48

Notes: The numbers are based on unweighted averages of the eight countries that are included in the economy-wide estimates. Column 1 is the price-induced change in unemployment due to wage rigidity; column 2 is the wage-induced change in unemployment due to price rigidity; column 3 is the productivity-induced change in unemployment because productivity changes mark-ups; and column 4 is the sum of columns 1–3, and column 5 is the actual change in unemployment. Unemployment is measured in percentages.

The simulations in Table 5 show the decomposition of the change in unemployment over the period from 1930 to 1932 using Eq. (15). The simulations in the upper half of the table are based on the estimates in rows 8 and 18 (U^{bc}) and the simulations in the lower part of the table are based on the estimates in rows 9 and 19 (U^{low}) in Table 4. It is important to note that the changes in p, w and pr in equations do not refer to the source of stickiness in Eq. (15). Changes in wages influence unemployment because of price stickiness. Similarly, changes in productivity influence unemployment because prices fail to clear the market. Hence, the third and the fourth terms in Eq. (15) constitute the joint effects on unemployment of price stickiness. Finally, the price-induced change in unemployment, which is represented by the second term in Eq. (15), represents the unemployment effects of wage stickiness.

The simulations explain the total increase in unemployment from 1929 to 1932 quite precisely. Based on U^{bc}, wage stickiness results in a 6-percentage point increase in the rate of unemployment, whereas price stickiness results in an 11.77-percentage point increase in the rate of unemployment over the period from 1929 to 1932. Based on U^{low}, wage stickiness results in a 4.37-percentage point increase in the rate of unemployment, whereas price stickiness results in a 5.83-percentage point increase in the rate of unemployment over the period from

1929 to 1932. These decompositions suggest that price stickiness was the main source of the supply failure, but that wage rigidity also played an important role.

These results are largely consistent with the microeconomic evidence. Although there is an extensive micro-oriented literature on price rigidity in U.S. manufacturing during the Depression, the literature is old. The classic studies of Burns (1936), Means (1935), and Berle and Means (1991, first printed in 1933) showed that U.S. manufacturing was highly concentrated and had sticky prices during the Depression. In 1929 the 100 largest U.S. manufacturing corporations controlled 44% of net capital assets in the U.S. (Berle & Means, 1991, p. 353). There was, therefore, plenty of scope for price rigidity. Burns (1936) listed several products for which prices remained unchanged, or changed only a little from the beginning of 1929 to the beginning of 1933. In the important U.S. automobile industry, prices only decreased 10%, whereas production fell almost 70%, from 1929 to 1931 (Federal Trade Commission, 1932). Another example is the U.S. agricultural implements industry where employment fell 82% from May 1929 to July 1932, but output prices decreased less than 10% (Means, 1935).

There is not much micro evidence on price rigidity during the Depression outside the U.S. There is, however, evidence that suggests a widespread and increasing degree of industrial concentration during the interwar period in most parts of the developed world. Supported by extreme nationalism among the public, governments were often the driving force behind the formation of cartels to strengthen the position of national industries in international markets and prevent rivals penetrating domestic markets (Wurm, 1989, p. 111; United Nations, 1947, pp. 8–9). The growing cartelization was often associated with the increasing tariffs and non-tariff trade barriers in the first part of the Depression, where the tariffs were imposed to strengthen the bargaining position of prospective cartel members in the cartel negotiations (United Nations, 1947, p. 21). Some governments even introduced legislation that made cartelization compulsory (United Nations, 1947, p. 10). Haussmann and Ahearn (1944) concluded from their statistical study that 42% of world trade over the period from 1929 to 1937 was cartelized or influenced by loosely knit associations or conferences.

Recent evidence on wage rigidity in the U.S. during the Depression suggests that wages responded to market forces. Hanes (2000), Lebergott (1989) and Mitchell (1985a, b) find that nominal wage cuts were widespread among U.S. firms and Mitchell (1985a, b) argues that wages first became rigid after the Depression. Comparing the degree of wage stickiness during the Depression with earlier contractions in the U.S., Dighe (1997) concludes that wages were not particularly rigid during the Depression and that wage rigidity was not an important causal factor in the Depression. Simon (2001) finds that asking wages among female clerical workers seeking employment fell by 58% from 1929 to 1933, and that agricultural workers experienced almost the same decrease. Although there is no evidence of wage flexibility among workers who were not seeking employment, it nevertheless shows that there was a potential threat to clerical and agricultural workers who refused wage cuts.

9. SUMMARY AND CONCLUSION

This paper has examined the extent to which the length and the depth of the Depression was a result of sticky prices and wages using a small supply side model which was estimated using annual data for industrialized and semi-industrialized countries for the interwar period. The model consisted of the labor market, which was represented by the Phillips curve, and the goods market, which was based on a price setting model. Based on panel data estimates, the model was simulated over the period from 1929 to 1932 and the unemployment effects of the demand shocks were decomposed into wage stickiness, price stickiness and productivity non-neutrality.

The estimates of economy-wide wage setting equations showed that wages adjust relatively quickly to innovations in prices and that wage growth was very sensitive to the level, but not to changes in unemployment and therefore that shocks had neither persistent, nor permanent effects on unemployment. A shock that brings wages up to a higher level results in unemployment in excess of the equilibrium unemployment rate, which in turn, puts effective downward pressure on wages until unemployment is eliminated. More sluggish wage adjustment was identified for manufacturing. Only about half of the adjustment in wages to innovations in prices was accomplished within the same year, and both the level and changes in unemployment were significant determinants of wage growth. The latter implies that shocks do have persistent, although not permanent, output effects. Wages were initially slow to respond to the adverse demand shocks, but as unemployment continued to grow up to 1932/1933, it exerted increasing downward pressure on wages, and helped to clear the labor market.

The estimates of the price equations showed that prices were slow to adjust to innovations in wages and that demand shocks only had one-off effects on prices, which suggests that there were no forces that automatically corrected disequilibrium in the goods markets and therefore that the labor market had to bear the adjustment costs. It appears that most of the economy-wide price stickiness stems from pronounced price stickiness in the manufacturing sector. The estimates indicated that manufacturing prices were slow to adjust to innovations in wages and their cyclicality was sensitive to measurements of demand.

A remarkable finding of the paper was that wholesale prices were completely insensitive to innovations in wages and were either insensitive to demand shocks or moved counter-cyclically. These findings suggest that if the same data as used in other international studies were used to test the degree of price rigidity, then it would have been concluded that the Depression was propagated by sticky prices and that wage flexibility could not have alleviated the Depression. This result underscores the importance of using the correct price deflators in studies of the supply side.

Robustness checks using various measurements of wages, prices and unemployment, different estimators, two different instrument sets, two different sectoral decompositions and estimators that were robust to errors-in-variables, indicated that the results were almost unaffected to these variations. An exception was the estimates using wholesale prices. The estimates confirmed the finding in the literature that wages are relatively insensitive to wholesale prices. It was shown, however, that this result is consistent with the fact that variations in wholesale prices were dominated by variations in commodity prices.

The results that price stickiness played a primary role during the Depression and that wage rigidity only played a secondary role stand in contrast to the results of the international studies of B&C (1996) and Eichengreen and Sachs (1985), where price stickiness did not play any role in the propagation of the Depression. The finding that sticky prices played a key role in the propagation of the Depression needs to be backed up by more microeconomic evidence. Previous microeconomic studies point towards widespread price stickiness within U.S. manufacturing. These studies, however, are mostly 60–70 years old, so new studies that use the tools of modern corporate finance and microeconomic theory would be highly desirable. Furthermore, very few studies of price stickiness outside the U.S. have been undertaken. New studies of price stickiness outside the U.S. would be especially valuable.

NOTES

1. They also estimate a labor demand function conditional on wages deflated by producer prices, but do not use these estimates in their simulations.
2. Finland and Spain are not included in the B&C sample.
3. Eichengreen and Sachs (1985) obtain a more significant negative relationship between the change in output and the change in real wages than obtained here. The difference reflects different sources of wage data.
4. Regressing the log of wholesale prices, p^{wpi}, on manufacturing hourly wages, w^{m}, the log of the exchange rate relative to its 1929 gold parity, e, and the log of notes in circulation, $h0$, yields the following estimates using annual data over the period from 1927

to 1937 for the 12 countries listed in Fig. 2:

$$\Delta\hat{p}_t^{\text{wpi}} = \underset{(2.25)}{-0.02} + \underset{(1.60)}{0.17}\Delta p_{t-1}^{\text{wpi}} + \underset{(4.95)}{0.65}\Delta w_t^{\text{m}} + \underset{(4.13)}{0.14}\Delta e_t + \underset{(4.07)}{0.30}\Delta h0_t, \quad R^2(\text{B}) = 0.39,$$

where R^2(B) is Buse's raw-moment R^2 and t-statistics are in parentheses. See Section 6 for the instruments used for wages and estimation method. The estimates show that wholesale prices are sensitive to exchange rates.

5. The supply function is derived from the following optimization problem of the perfect competitive firm where output is measured as gross output:

$$\max \pi = P^{\text{o}}Y^{\text{o}}(K, L, Q^{\text{c}}) - WL - P^{\text{c}}Q^{\text{c}}.$$

6. The results below are not affected by alternative weightings (0.7 and 0.3, or 0.9 and 0.1). Similar results were also obtained if real commodity prices were used as separate arguments in the output supply function.

7. For agriculture, for instance, supply is over a wide range of output independent of real product wages since land is a fairly fixed factor of production. Land prices, rather than supply, are likely to be affected by real wages.

8. The cyclicality of prices need not depend on the cyclicality of mark-ups. Prices can also vary on a cyclical basis due to increasing or decreasing returns to scale and labor hoarding.

9. More complete pricing models that allow for number of firms and for strategic interaction among firms are derived in Hay and Morris (1991).

10. Actual labor productivity did not change much during the Depression. Whether this modest change was reflected in expectations cannot be tested.

11. Economy-wide non-residential capital stock was initially used as an additional regressor in the estimates of Eq. (9), however, its estimated coefficient was insignificant and the parameter estimates of the other variables were insensitive to its inclusion. It was, therefore, not included in the estimates because it would have increased the Data Appendix substantially.

12. See Madsen (2001b) for construction of the competitiveness index.

13. The only difference is that the import prices used by B&C in the instruments are derived from the wholesale prices of exporting countries, whereas this paper uses import unit values as instruments.

14. The data used by B&C commence in 1929. The same data are available before that time from their sources. Wages commence in 1927 from the ILO *Yearbook* and the same series are available in earlier years from the League of Nation, *Monthly Bulletin of Statistics* and League of Nation, *Statistical Yearbook*.

15. This exercise is not undertaken for the estimates where the wholesale price deflator is used because the measurement error in wholesale prices is likely to be highly serially correlated as argued in the previous section, and therefore renders the Griliches-Hausman transformation invalid.

16. Equation (10) was also estimated with asymmetric adjustment of wages to positive and negative price changes to allow for downward nominal rigidity but not upward rigidity as suggested by Keynes (1936, pp. 13–15). However, the null hypothesis of symmetrical wage adjustment could not be rejected at any conventional significance levels.

17. More formally the generalised instrumental variable method is used, where the covariance matrix is weighted by the correlation of the disturbance terms using the

variance-covariance structure as follows:

$$E\{\varepsilon_{it}^2\} = \sigma_i^2, \quad i = 1, 2, \ldots, N,$$
$$E\{\varepsilon_{it}, \varepsilon_{jt}\} = \sigma_{ij}, \quad i \neq j,$$

where σ_i^2 = the variance of the disturbance terms for country $i = 1, 2, \ldots, N$; σ_{ij} = the covariance of the disturbance terms across countries i and j; and ε is the disturbance term. The variance σ_i^2 is assumed to be constant over time but to vary across countries and the error terms are assumed to be mutually correlated across countries, σ_{ij}, as random shocks are likely to impact on all countries at the same time. σ_i^2 and σ_{ij}, are estimated using the feasible generalised least squares method described in Greene (2000, Chap. 15).

18. The estimates of the wage reducing effects of the level of unemployment are based on the deviation of unemployment from its "natural rate," where the "natural rate" is the absolute value of the ratio of the constant term and the coefficient of unemployment.

19. Note that the estimates cannot be compared with the B&C estimates because their dependent variable is the level of wages, not the change in wages.

20. Unemployment is measured in first differences in their first-difference estimates.

21. Akaike's information criterion gave the results as follows; −0.743 using U^{low}, −0.716 using U^{bc} and −0.744 using output; thus favoring the models with unemployment as demand shift variables. Non-nested tests (*J*-tests) yielded the results as follows: Including the predicted value from the model with output as a regressor in the models with unemployment as regressor gave the *t*-values of 0.46 (the model with U^{low}) and 1.09 (the model with U^{bc}), which suggests that the model with output as regressor does not encompass the models with unemployment as a regressors. Including the predicted value from the regressions with U^{low} and U^{bc} as demand shift factors in the model with output as a regressor gave the *t*-values of 2.28 and 2.02, respectively. Hence, the models with unemployment as the regressors encompass the model with output as the regressor.

22. The tests of the null hypothesis that the coefficients of wages and prices divided by one minus the coefficient of the lagged dependent variable gave the following chi-squared test statistics: $\chi^2(1) = 2.83$ (row 8), $\chi^2(1) = 7.26$ (row 9), $\chi^2(1) = 24.55$ (row 18), and $\chi^2(1) = 9.63$ (row 19).

23. This is probably the reason why Dimsdale, Nickell and Horsewood (1989) do not decompose the unemployment effects of sticky wages and prices for the U.K.

ACKNOWLEDGMENTS

Helpful comments and suggestions from participants at the 2001 Cliometrics conference and at seminars at University of New South Wales, University of Western Australia, and University of Waikato, and especially a referee, are gratefully acknowledged. Randall Fox, Paula Madsen, Signe Skarquist, Nick Tsitsianis and Wana Yang provided excellent research assistance. The estimates were programmed in Gauss and Shazam.

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APPENDIX: ECONOMETRIC ISSUES

This appendix discusses the reasons why both the within (fixed effect) and the first difference estimators are used in the estimates of Eq. (9). The first-difference estimates may lead to less biased estimates of the lagged dependent variable than the within estimates. When T is low, the coefficient of the lagged dependent variable in the within estimates is negatively biased and converges towards approximately minus one for $T = 2$ and $N \rightarrow \infty$ due to the correlation between the error terms and the fixed effects (see Hsiao, 1986). This bias does not disappear by taking first differences, even if $T \rightarrow \infty$ (Kiviet, 1995). A second source of bias in estimates of the coefficient of the lagged dependent variable comes from the correlation between the lagged dependent variable and the error term. Using instruments for the lagged dependent variable or estimating in first differences to remove the fixed effects, will alleviate the problem of biased estimates of the estimated coefficient of the lagged dependent variable; however, Monte Carlo simulations by Kiviet (1995) show that various transformations of the data and alternative estimators, including the GMM estimator, do not the resolve the bias and consistency problems because of the correlation between the error terms and the fixed effects in small samples. To alleviate the consistency problem two period lags of the dependent variable are used as instruments for the lagged dependent variable, following B&C. This is not the most efficient method since all orthogonal conditions have not been exploited (Arellano & Bond, 1991). The first-difference models in this paper were also estimated using the generalised method of moments (GMM) estimator devised by Arellano and Bond (1991), and produced estimates of the lagged dependent variables that were higher than the estimates in this paper, but the estimates of the other coefficients were quite similar. It is, however, not clear which estimation method is the best. Hahn and Hausman (2002) show that the bias in the instrument variable estimator is positively related to the number of instruments. Since the GMM estimator uses a substantial number of instruments, it is not clear whether the efficiency gain from using the GMM estimator outweighs the instrumental variable bias. Second, the GMM estimator of Arellano and Bond is derived for $N \rightarrow \infty$, which is not even approximately satisfied here.

Another advantage of estimating in first differences is that it eliminates serial correlation in the residuals. Although serial correlation is allowed for in the level estimates, the serial-correlation coefficient needs to be restricted to be the same across countries because T is too low to relax this assumption in most of the estimates. If this restriction is violated, then the parameter estimates will become inconsistent and biased.

If some regularity conditions are satisfied, consistent estimates can be recovered from a combination of first-difference and the within estimates as shown by Griliches and Hausman (1986). Suppose that the following model is estimated for a panel of i countries:

$$y_{it} = \alpha_i + \beta x_{it} + u_{it},$$

where u is a stochastic error-term and x is measured with an error:

$$x^*_{it} = x_{it} + v_{it}$$

where x^* is the observed x and v is the measurement error, then we get the following probability limits for the within and the first-difference estimator, respectively:

$$P \lim_{N\to\infty} \hat{\beta}_d = \beta \left(1 - \frac{2\sigma^2_v}{\sigma^2_{\mathrm{d}x}}\right), \quad P \lim_{N\to\infty} \hat{\beta}_w = \beta \left(1 - \frac{T-1}{T}\frac{\sigma^2_v}{\sigma^2_{\tilde{x}}}\right) \tag{A1}$$

where $\mathrm{d}x_{it} = x^*_{it} - x^*_{i,t-1}$, $\tilde{x}_{it} = x^*_{it} - \overline{x}^*_{it}$, $\sigma^2_{\mathrm{d}x}$ is the variance of the first differences of x, and $\sigma^2_{\tilde{x}}$ is the variance of the within transformed x^*'s. These probability limits are derived under the assumption of no serial correlation in the measurement errors.

From Eq. (A1) it follows that the within estimator is likely to be less sensitive to errors-in-variables than the first-difference estimator because the condition $\sigma^2_{\mathrm{d}x} < 2\sigma^2_{\tilde{x}}T/(T-1)$ is likely to be satisfied (Griliches & Hausman, 1986).

Equation (A1) can be solved to yield the following consistent estimate of β:

$$\beta = \frac{\phi_1\hat{\beta}_w - \phi_2\hat{\beta}_d}{\phi_1 - \phi_2}, \tag{A2}$$

where $\phi_1 = 2/\sigma^2_{\mathrm{d}x}$ and $\phi_2 = (T-1)/T\sigma^2_{\tilde{x}}$. This result is derived under the assumption that the measurement error is serially uncorrelated.

If the measurement error is serial correlated, then the within estimator need not be less biased than the first difference estimator because the first difference transformation eliminates some of the measurement error. This can be seen from the following. Assuming that $\mathrm{cov}(x_{it}, u_{it}) = \mathrm{cov}(\alpha_i, v_{it}) = \mathrm{cov}(x_{it}, v_{it}) = \mathrm{cov}(\alpha_{it}, u_{it}) = \mathrm{cov}(u_{it}, v_{it}) = 0$, then the probability limit of the least squares estimator is (Griliches & Hausman, 1986):

$$P \lim_{N\to\infty} \hat{\beta}_w = \beta \left(1 - \frac{\sigma_v^2}{\sigma_x^2 + \sigma_v^2}\right),$$

$$P \lim_{N\to\infty} \hat{\beta}_d = \beta \left(1 - \frac{\sigma_v^2}{(1-\rho_x)/(1-\rho_v)\sigma_x^2 + \sigma_v^2}\right),$$

where ρ_x is the first-order serial-correlation coefficient of (the level of) x_{it}, and ρ_v is the first-order serial-correlation coefficient of (the level of) v_{it}. Comparing the two estimators, the first-difference estimator is more inconsistent than the level estimator if x_{it} is more serially correlated than the measurement error, which is most likely to be the case for the variables used here except perhaps for wholesale prices.

To examine the seriousness of the errors-in-variables problem Eq. (A2) is used to recover consistent estimates of the real wage elasticity of output in some of the estimates below. In these estimates the coefficients of the log of prices and wages are restricted to be the same and of opposite sign because the results become much more complex if more than one independent variable is measured with an error. Since, the restriction cannot be rejected at conventional significance levels in most circumstances, as shown below, this restriction will not impact on the results. Furthermore, the coefficients of *Str* and *Panic* are restricted to zero to simplify the analysis.

APPENDIX: DATA

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Press, divided by manufacturing output, Table 51, Feinstein, C H, 1976, *Statistical Tables of National Income, Expenditure and Output of the U.K. 1855–1965*, Cambridge: Cambridge University Press. **Hourly wage earnings in manufacturing**. Mostly from ILO, *Yearbook of Labor Statistics*, and backdated from 1927 using League of Nation, *Monthly Bulletin of Statistics* and League of Nation, *Statistical Yearbook*. The coverage of the data, and if the sources differ from the sources above, for each individual country are the following, where *I* signifies agriculture, *II* mining, *III*, manufacturing, building, construction, power and water, *IV*, transport and communication, *V*, public administration, and *IV*, commerce and personal services, following the ILO classification. Hourly earnings across skills and genders are used unless mentioned. *Argentina*. *III, IV, VI*, Buenos Aires, monthly earnings, after 1929. Before 1929, J G Williamson, 1995, "The Evolution of Global Labor Markets since 1830: Background Evidence and Hypothesis," *Explorations in Economic History*, 32, 141–196. The wage data are deflated by consumer prices and are therefore multiplied by consumer prices to convert them to nominal wages. *Australia*. II, III, IV, rates for males. *Austria*. II, earnings per shift. *Belgium*. *II, III, IV*. Before 1929, B R Mitchell, 1975, *European Historical Statistics 1750–1975*, London: Macmillan. *Canada*. Industry wages, B R Mitchell, 1983, *International Historical Statistics: Americas and Australasia*, London: Macmillan. *Czech-Slovakia*. III, hourly minimum rate in Prague. *Denmark*. III, IV. *Estonia*. III. *Finland*. Mitchell, 1975, *op cit*., money wages in industry. *France*. *III*, *IV*, hourly rates for skilled men in Paris. *Germany*. II, III, IV. 1925–1928, G Bry, 1960, *op cit. Hungary*. *III*. *Italy*. III. Before 1927, Mitchell, 1975, *op cit*., average daily wages. *Japan*. III, daily earnings, Imperial Cabinet. *Latvia*. III, skilled men. New Zealand. *I, II, III, IV*, men. *Netherlands*. *II, III*, men. Before 1928, Williamson, 1995, *op cit*., average daily earnings. *Norway*. *II*, *III*, daily earnings for men. Before 1928, Mitchell, 1975, *op cit.* hourly earnings for engineering. *Poland*. II, III. *Spain*. *III*, 1925–1933, Table 12.14, A Carreras, 1989, *Estadisticas Historicas de España*, Madrid: Fundacion Banco Exteriror. 1934–1938, Williamson, 1995, *op cit*., workers in building trades in Madrid, unweighted average. *Sweden*. *II*, *III*, *IV*, *VI*. *Switzerland*. *III*, *IV*, men. Before 1929, Mitchell, 1975, *op cit*., weekly earnings for males involved in accidents. *U.K. I, II, III, IV, V*. Weekly rates. *United States*. *III*, C Hanes, 1996, "Changes in the Cyclical Behavior of Real Wage Rates, 1869–1990," *Journal of Economic History*, 56, 837–861. **Alternative wage set**. The same wage data are used except for the follwing countries. *Belgium*. Average of several professions, Williamson, 1995, *op cit. Canada*. *III*, Unskilled men. *Czech-Slovakia*. I, III, VI, daily insured wages. *France*. Average for all sectors, Williamson, 1995, *op cit. Japan*. III, daily earnings, Bank of Japan. *U.K.* Compensation to employees in manufacturing, Table 8, Feinstein, *op cit*, divided by manufacturing employment, Table 59, Feinstein, *op cit*., and hours worked in manufacturing, ILO, *Yearbook of Labor Statistics*. **Commodity price index**. For all countries except Denmark: Warren and Pearson, 1937, *World Prices and the Building Industry*, London: John Wiley and Sons. Index for 40 basic commodities, where the same weighting was used for all countries. The weights reflect the importance of the commodity in the world. **Consumer prices, wholesale prices, currency in circulation, and exchange rates**. League of Nations, *Monthly Bulletin of Statistics*, Geneva. Indirect and direct tax rates. Direct and indirect taxes divided by nominal GNP. Direct and indirect taxes: B R Mitchell, 1982, *International Historical Statistics: Asia and Africa*, London: Macmillan, Mitchell, 1975, *op cit.* and Mitchell, 1983, *op cit*. **Export price competitiveness**. Multilateral index using export unit values as deflators. See J B Madsen, 2001, "Trade Barriers and the Collapse in International Trade during the Great Depression," *Southern Economic Journal*, 67, 848–868, for construction and data sources. **Unemployment**. Two sets of unemployment data are used. The first set is based mainly on union unemployment statistics and is calculated by W Galenson and A Zellner (1957), *Measurement and Behavior of Unemployment*, NBER, Princeton: Princeton University Press, for 10 countries. ILO's, *Yearbook of Labor Statistics*, Geneva, is used for the remaining countries. For Argentina, Austria, Estonia, Hungary, Italy, Latvia, New Zealand, Poland, and Spain, for which unemployment data are not available, unemployment is generated from manufacturing employment using the following method. The change in unemployment is regressed on the change in manufacturing employment over the period from 1930 to 1936 using pooled cross-section and time-series data for the countries where both series are available. The coefficient of the change in manufacturing employment is used to simulate unemployment series in first differences for the countries where unemployment data are not available. Finally, the level of unemployment is generated by accumulating the first-differencing unemployment data. The other set of unemployment data are based on estimates for the whole labor force and is only used for the 12 countries for which the manufacturing value-added price deflator is available. The following sources are used. *Canada*. A Maddison, 1964, *Economic Growth in the West. Comparative Experience in Europe and North America*. London: George Allen & Unwin LTD. *USA*. 1925–1930, C Romer, 1986, "Spurious Volatility in Historical Unemployment Data," *Journal of Political Economy*, 94, 1–37. 1931–1939: M R Darby, 1976, "Three and a Half Million U.S. Employees have been Mislead: Or, and Explanation of Unemployment," *Journal of Political Economy*, 84, 1–16. *Japan*. Galenson and Zellner *op cit*. Australia. M Keating, 1973, Australian Workforce and Employment 1910–1911 to 1960–1961, the Australian National University, Canberra. *Denmark*. 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B Eichengreen, 1992, *Golden Fetters: The Gold Standard and the Great Depression, 1919–1939*, Oxford University Press: Oxford. **Short-term interest rates**. League of Nations, *Money and Banking* and *Monthly Bulletin*, Geneva. **Economy-wide GNP deflator**. Nominal GNP divided by real GNP. *Canada*. Table C.1, T Liesner, *op cit*. *USA*. Table U.S.1, T Liesner, *op cit*. *Japan*. Tables A1 and A2, K Ohkawa et al., *op cit*. *Finland*. Tables 1 and 2, R Hjerppe, *op cit*. *France*. Table F.1, T Liesner, *op cit*. *Germany*. Table G.1, T Liesner, *op cit*. *Netherlands*. Van Bochove and Huitker, *op cit*. *U.K.* Table U.K.1, T Liesner, *op cit*. **Import unit values, import value and macro tariff rates**. See Madsen, 2001, *op cit.* for sources.