DEFLATION IN ASIA: SHOULD THE DANGERS BE DISMISSED?

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ABSTRACT

Deflation has emerged as a new concern for Asian policy makers. The traditional view is that deflation can lead to a vicious cycle of falling demand and prices, and is thus a dangerous condition. However, another school of thought emphasizes the role of positive supply shocks and takes a more benign view of deflation. In a recent paper that examines the relationship between deflation and economic growth, using consumer prices time series, Borio et al. (2015) find some evidence that casts doubt on the traditional view. In this paper, we revisit the relationship and find some grounds for concern about the harmful effect of deflation on growth.

Keywords: deflation, growth, producer prices

JEL code: E31

I. INTRODUCTION

Deflation is a relatively new phenomenon in Asia. Where deflation was once regarded as a peculiarly Japanese problem, the phenomenon—and concern over it—has spread to other Asian economies. Visibly slower growth since the global financial crisis has combined with weak global oil and other commodity prices to contain inflationary pressures. While this provided the region's central banks with room for countercyclical monetary expansion, there are concerns that inflation is now too low. Although consumer price inflation generally remains positive, producer prices fell in 2015 in a number of economies in the region, including the People's Republic of China (PRC), India, the Republic of Korea, Malaysia, the Philippines, and Thailand (Table 1).

Table 1: CPI and PPI Inflation Rates, Selected Asian Economies

	CPI Inflation		PPI Inflation	
Economy	2015	Dec 2015	2015	Dec 2015
People's Republic of China	1.4	1.6	−5.2	−5.9
Hong Kong, China	3.0	2.5	−2.7	−3.2
India	4.9	5.6	−2.7	−0.7
Japan	0.8	0.3	−2.2	−3.4
Republic of Korea	0.7	1.3	−4.0	−4.0
Malaysia	2.1	2.7	−4.8	−1.6
Philippines	1.4	1.5	−6.7	−7.2
Singapore	−0.5	−0.6	−9.1	−7.7
Thailand	−0.9	−0.9	−4.1	−2.7

CPI = consumer price index, PPI = producer price index.
Note: Hong Kong, China's latest PPI inflation rate is Q4 2015 instead of December, due to lack of monthly published data.
Sources: National Bureau of Statistics (PRC); Census and Statistics Department (Hong Kong, China); Statistics Bureau (Japan); Statistics Korea (Republic of Korea); CEIC Data Company (Philippines and Thailand); Department of Statistics (Singapore).

Indeed, as of February 2016, the PRC had experienced producer price deflation for 47 consecutive months. With a slowing Chinese economy giving rise to talk of renminbi depreciation, there are growing fears that deflation in the PRC will be transmitted to the country's neighbors via lower Chinese export prices. With growth in other parts of the world already slow and now potentially decelerating further, external demand for Chinese and East Asian exports remains subdued, making for further downward pressure on prices. And with interest rates in many Asian economies already low, there is little that central banks can do about it. All this raises the possibility that additional deflation could be in the pipeline.

The traditional view is that deflation is a dangerous condition to be avoided at all cost (see, for example, Fisher 1933 and Friedman and Schwartz 1963 for standard references). Deflation makes domestic-currency debts not indexed to the price level (which in practice means most domestic-currency debts) more difficult to service and repay. Those difficulties in turn threaten to create balance sheet problems and losses for the creditors, prominent among them domestic banks and other institutional investors. Debtors desperate to avoid incurring the costs of default and renegotiation, for their part, are apt to tighten their belts. Firms therefore curtail their investment projects, while households limit their spending on big ticket items in particular, further weakening demand.

Expectations of falling prices make even those with the wherewithal to continue investing and consuming delay their purchases in anticipation of still lower prices in the future. For all these reasons, once deflation is allowed to commence, it can gather momentum and will tend to persist. And the impotence of conventional monetary policy at the zero lower bound—together with the inability of central banks to cut interest rates further—means that central banks have little capacity to counter the downward spiral.

Against this view, there have long been voices questioning the conventional wisdom that deflation is a worrisome phenomenon. Prices can decline not just because of negative demand shocks but also because of positive supply shocks.[1] This benign positive-supply-shock interpretation was the dominant view of producer price deflation in the PRC so long as that country was growing strongly. With total factor productivity rising by fully 6% per annum, Chinese producers were fully capable of cutting prices and at the same time maintaining profitability. And with their production expanding strongly, it was necessary for a country as large as the PRC to cut prices repeatedly in order to sell its increased output into global markets. None of this, in other words, necessarily represented a problem. The same benign interpretation of recent experience could be applied, to a greater or lesser extent, to other Asian success stories as well. To be sure, now that total factor productivity growth and economic growth more generally appear to be decelerating in the PRC and elsewhere in East Asia, this benign interpretation becomes more difficult to maintain.[2] But it can still be argued, on this basis, that the dangers of deflation have been overstated.

The principal exponents of this last conclusion are economists at the Bank for International Settlements (Borio and Filardo 2005, Borio et al. 2015). In their 2015 paper, the authors consider the association between the consumer price index (CPI) and the rate of growth of per capita gross domestic product (GDP) since 1870 for a wide range of economies. They distinguish different eras (that of the classical gold standard, the interwar period, the period since World War II) and different kinds of deflation (transient versus persistent). They find few significant differences in the rate of growth of GDP between periods of inflation and deflation, the notable exception being the decade of the Great Depression starting in 1929, a deflationary event that was persistent and, according to the scholarly consensus, dominantly the result of a negative demand shock.[3] The implication is that researchers have inappropriately generalized the experience of an exceptional period, 1929–1933, when deflation was exceptionally rapid and persistent, to other periods. They have applied the conclusion that deflation must be avoided at all cost also to other circumstances where it is not apposite.[4]

But failure to reject a null hypothesis (in this case, the null hypothesis that there is no significant difference in the growth rate between periods of inflation and deflation) "does not imply that the null is true; the test may simply be not very powerful" (Hodrik 2014). Relatively short time series make it hard to reject a null. The price index may be noisy, where random noise raises standard errors and biases coefficients toward zero.[5] The price index utilized may not be the one relevant to the consumption and investment decisions of agents; consumers care about consumer prices, while

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1 Bordo and Redish (2004) refer to these as "good" and "bad" deflations.

2 Even for the earlier period, Siklos and Zhang (2010) conclude that demand shocks were at least as important (and maybe more important) than supply shocks as a source of Chinese deflation.

3 On the nature of shocks in the Great Depression and the relevance of the debt deflation interpretation see Fackler and Parker (2005).

4 Akeson and Kehoe (2004) draw similar conclusions.

5 Random noise/random errors in the dependent variable (the rate of growth of real per capita GDP) are less troubling from a strictly econometric point of view, but there is also the possibility that noise is not random.

producers presumably care about producer prices.[6] The further back in time one goes, the more limited is the range of items included in consumer price indices (19th century consumer price indices being heavily based on the cost of food and shelter, or even only food). This reality is reflected in the fact that, possessing relatively abundant information on farm- and factory-gate prices, contemporaries already in the 19th century constructed their own estimates of producer (wholesale) prices, whereas estimates of consumer prices tend to be constructed retrospectively by economic historians, often using relatively fragmentary data and ancillary assumptions.

In this paper, we therefore revisit the association between deflation and economic growth using time series for producer prices. We find more evidence than in other recent studies, cited above, that deflation is damaging. We find more evidence that the damaging effects are not limited to the interwar period or the Great Depression years 1929–1938. Evidence of inferior growth performance in periods of deflation comes through more clearly when we exclude episodes of relatively high inflation, which can also be disruptive to growth. No study of this sort can definitively answer the question of whether or not deflation should be regarded as a problem. But, compared to other recent work, our findings provide more grounds for worrying.

II. DATA

Our data start with those used in the Borio et al. (2015) study. These cover 38 now advanced countries and emerging markets.[7] The panel is unbalanced: country coverage improves over time. (See Appendix Table A.1 for details.) After updating their data, we added series for producer prices from Global Financial Data (GFD). GFD assembles its series on producer prices from a variety of different sources. For the post-World War II period, these tend to be government-generated time series, for some countries for the price of manufactures, for other countries for the price of commodities (both industrial and agricultural) more generally. Limiting coverage to the prices of manufactured goods matters relatively little for places like Japan where agriculture is only a small sector (and where the producer price index, or PPI) covers only the factory-gate price of manufactures). For other countries, including those where agriculture remains more consequential, coverage tends to be wider; in the case of the United States (US), for example, the Bureau of Labor Statistics seeks to include the "entire marketed output of U.S. producers" (BLS 2016).

For earlier historical periods, the producer price indices (PPI) provided by GFD are also known as wholesale price indices. It is worth asking whether the two series—wholesale price indices and producer price indices—are in fact comparable to one another. For some countries, like the US, it is easy to verify that this is the case. The US Bureau of Labor Statistics describes how the BLS series for the prices of goods received by and traded among producers was referred to as the wholesale price index from the inception of public provision in 1902 until 1978, when the series was renamed as the PPI. That change in name "did not include a change in index methodology, and the continuity of the

[6] A related literature argues that wage stickiness is an important factor in the business cycle, with real wages rising, countercyclically and counterproductively, precisely when activity turns down due to negative demand shocks, and that it is nominal wages relative to producer prices that matter for firms' employment and production decisions. Contributions to this literature generally find that PPI-deflated real wages are countercyclical, and therefore provide a channel through which demand shocks affect the economy, while CPI-deflated real wages are acyclical. See Swanson (2004) and Messina, Strozzi, and Turunen (2009).

[7] These data were assembled from GFD, Brian Mitchell's (1993) compendium of *International Historical Statistics* and Schularick and Taylor (2012). See Appendix Table A.3 for detailed information on sources of other data as well as information on prices.

price index data was unaffected" (BLS 2016).[8] Upon inauguration in 1902, the BLS constructed wholesale price indices back to 1890 using the same methodology. The source of US data in GFD for the years immediately prior to 1890 is not entirely clear, but these are most likely drawn from pioneering and still definitive index building by Warren and Pearson (1933), which followed analogous methods.

This effort to recover the sources of commonly used series could similarly be undertaken for other countries. It is a reminder that there may have been repeated changes in commodity coverage, definition and in some cases methodology, affecting both the CPI and the PPI, creating the appearance of changes in the cyclical sensitivity of what are superficially the same price aggregates.

It is also worth reflecting on how the behavior of consumer and producer price indices is likely to differ. By definition, consumer price indices measure price changes from the point of view of the buyer, while producer price indices measure them from the point of view of the seller, where sellers' and purchasers' prices will differ because of government subsidies, sales and excise taxes, and distribution costs. Insofar as taxes, subsidies and perhaps also distribution costs are slow to change, consumer prices may exhibit less volatility and more persistence than producer prices. Insofar as one is interested in the impact of deflation on production decisions, it makes most sense to focus on producer prices. Insofar as one is interested in spending decisions, it will make sense to focus on a combination of consumer prices and producer prices (because the former are most relevant to the spending decisions of households, whereas both will be relevant to the spending decisions of firms).[9]

III. RESULTS

Table 2, following Borio et al. (2015), shows summary statistics for both CPI and PPI inflation/deflation in different eras and under different monetary regimes. Following Borio et al. 2015, we exclude observations from the war years 1914–1918 and 1939–1945 and in the case of Spain, observations from the Civil War years 1936–1939. We also exclude observations from years of extremely high inflation, i.e. higher than 100%.

The correlation between the change in the PPI and the CPI, at 0.88, is high in general but noticeably lower in the classical gold standard years than subsequent periods. The correlation between the two measures of changes in the price level is higher in years when the CPI is going up than in years when it is going down, pointing in particular to sensitivity in the data for how deflationary periods are identified (and for how deflationary such periods were). This last pattern is due mainly to the much lower correlation of the two inflation measures in years when prices were going down in the period after World War II; evidently, the incidence of episodes of CPI and WPI deflation has been very different since World War II, but not so different before. There are well more than twice as many years of PPI as CPI deflation after World War II, whereas the number of years of PPI and CPI inflation in earlier periods is much more similar.[10] This suggests that relying on a single index for measuring deflation is likely to be especially problematic when focusing on the post-World War II years.

[8] There is, however, some slightly unsettling commentary in BLS 1966 that the term "wholesale" is used because producers tend to sell to one another in relatively large quantities, which in turn suggests that coverage in the earlier years of the official series was less complete than it became later.

[9] The logic for the last statement in the text is that a firm considering an investment decision will presumably consider the relationship between what it can expect to earn from additional capacity and therefore additional sales (and hence prices from the seller's point of view) but also the cost of the relevant inputs (and hence prices from the buyer's point of view).

[10] The contrast is even stronger when we consider periods of persistent deflation, as described below.

Table 2: CPI and PPI Deflations: An Overview

			Full Sample	Classical Gold Standard (1870–1913)	Interwar (1920–1938)	1920–1928	1929–1938	Great Depression (1930–1933)	Postwar (1947–2014)
All	CPI	Number of inflation years	2,940	341	269	122	147	25	2,332
		Number of deflation years	658	265	248	102	146	89	145
	PPI	Number of inflation years	2,443	328	201	76	125	26	1,914
		Number of deflation years	921	288	244	111	133	75	389
	CPI	Average duration (years)	1.87	1.96	2.25	1.96	2.25	2.62	1.36
		Average rates (%)	−4.05	−3.82	−5.62	−6.75	−4.82	−6.13	−1.81
	PPI	Average duration (years)	1.77	2.07	2.35	2.09	2.11	2.14	1.41
		Average rates (%)	−5.03	−4.91	−8.78	−10.12	−7.66	−9.85	−2.78
Persistent deflations	CPI	Number	76	41	30	20	27	27	5
		Average duration (years)	7.21	6.56	8.37	6.15	4.74	3.37	5.60
		Average rates (%)	−3.27	−2.49	−4.31	−4.04	−4.57	−5.62	−1.40
	PPI	Number	92	36	27	25	24	24	29
		Average duration (years)	7.38	7.67	9.85	6.04	4.79	3.21	4.72
		Average rates (%)	−4.30	−3.16	−6.36	−5.99	−6.84	−8.41	−2.63
Correlation		All	0.88	0.30	0.71	0.75	0.69	0.70	0.92
		CPI inflation	0.89	0.08	0.54	0.62	0.57	0.77	0.92
		CPI deflation	0.52	0.14	0.69	0.78	0.46	0.48	0.14
Number of economies in sample	CPI		38	19	32	28	32	30	38
	PPI			38	20	29	23	29	28

CPI = consumer price index, PPI = producer price index.

Note: Economies in sample: Argentina; Australia; Austria; Belgium; Brazil; Canada; Chile; People's Republic of China; Colombia; Denmark; Finland; France; Germany; Greece; Hong Kong, China; Ireland; Italy; Japan; Republic of Korea; Malaysia; Mexico; The Netherlands; New Zealand; Norway; Peru; Philippines; Portugal; Singapore; South Africa; Spain; Sweden; Switzerland; Thailand; Turkey; United Kingdom; United States; Uruguay; and Venezuela. Full sample excludes observations from the war years 1914–1918 and 1939–1945 and in the case of Spain, observations from the Civil War 1936–1939. We also excluded, through the periods, observation from years with inflations higher than 100%. Persistent deflations are defined as years following a price peak that is identified as a turning point exceeding price index levels in the preceding and subsequent 5 years. Duration of persistent deflations is calculated from peak to trough.

Sources: CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators.

The average rate of change of the price level in deflation years is consistently greater (in absolute value) when we consider the PPI than when we consider the CPI. PPI deflation is half again as fast in these episodes; the differential is roughly the same regardless of subperiod. All this is consistent with the idea that the consumer price index is stickier than the producer price index, including in the downward direction.

Persistent deflations are defined, following Borio et al. 2015, as periods following price-level peaks when prices fall significantly.[11] We identify more years of deflation of this persistent type when we consider the PPI rather than the CPI. The difference is accounted for almost entirely by the years since 1947. When using the CPI, there is only a small handful (five) number of persistent deflations, so measured, in the 38 economies in the sample. But when using the PPI there are 29 such deflations. Again, this suggests that relying only on the change in the CPI as a gauge of persistent deflation may be especially problematic for the post-World War II period.

Table 3 tabulates the growth rate of GDP per capita in inflation and deflation years using both the CPI and PPI. We divide the inflation years into years of high and low inflation, according to whether inflation is greater or less than 10%, on the grounds that the disruptive effects of inflation are likely to be more pronounced when price increases are relatively rapid. We further distinguish years of deflation from years of persistent deflation, as defined above.

The summary statistics in the table confirm that growth is slower on average in years of high inflation than years of low inflation. The null of no difference in the average GDP growth rate is rejected in the full sample, which is mainly driven from the experiences of the postwar era. Over the full sample, growth is significantly slower in periods of deflation than in periods of high inflation, whether inflation is measured using the PPI or the CPI. It is significantly slower in periods of deflation than in periods of low inflation, again regardless of the price index used.

At a more disaggregated level, our results for CPI inflation are similar to those of Borio et al. (2015), except where they report that the null of no difference in the average GDP growth rate in the Great Depression years (1930–1933) cannot be rejected even at the 10% level, our statistics reject this null at the 1% level of confidence when we compare low inflation with deflation. When we consider the PPI rather than the CPI, we reject the null for the post-World War II. Again, this points to the potential sensitivity of findings to the particular price index used, particularly for the years since World War II.

[11] While Borio et al. (2015) defined peaks by using the 5-year moving average, we simply defined peaks as turning points exceeding price index levels in the preceding and subsequent 5 years. The reason for this is that we could not identify the same peaks as Borio et al. (2015) if we use 5-year moving averages. Our methodology does not identify exactly the same peak years, but generates reasonably well-matched peaks. See Appendix Table A.2 for the list of peak years.

Table 3: CPI and PPI Deflations and per Capita Real GDP Growth

			Full Sample	Classical Gold Standard (1870–1913)	Interwar (1920–1938)	1920–1928	1929–1938	Great Depression (1930–1933)	Postwar (1947–2014)
Average per capita real GDP growth	CPI	(1) High inflation	2.31	1.17	3.02	3.49	2.13	−2.90	2.28
		(2) Low inflation	2.74	1.60	3.70	3.43	3.87	2.46	2.83
		(3) Deflation	1.17	1.17	0.36	2.20	−0.90	−3.03	2.55
		(4) Persistent deflation	0.85	0.98	0.44	2.42	−1.41	−3.09	3.25
	PPI	(5) High inflation	2.42	1.51	4.66	5.87	3.76	3.47	2.28
		(6) Low inflation	2.75	1.86	3.72	4.60	3.23	−1.82	2.84
		(7) Deflation	1.40	1.29	0.42	2.07	−0.91	−3.36	2.10
		(8) Persistent deflation	1.22	1.20	0.63	2.50	−1.76	−3.89	2.36
Mean equality test	(1) vs (2)	Difference	−0.43**	−0.43	−0.68	0.06	−1.74	−5.37	−0.54***
			[0.01]	[0.65]	[0.37]	[0.95]	[0.15]	[0.19]	[0.00]
	(1) vs (3)	Difference	1.14***	0.00	2.67***	1.29	3.03**	0.13	−0.27
			[0.00]	[1.00]	[0.00]	[0.22]	[0.04]	[0.97]	[0.53]
	(2) vs (3)	Difference	1.57***	0.43	3.34***	1.23	4.78***	5.50***	0.27
			[0.00]	[0.23]	[0.00]	[0.13]	[0.00]	[0.00]	[0.31]
	(5) vs (6)	Difference	−0.33*	−0.35	0.95	1.27	0.53	5.29	−0.56***
			[0.05]	[0.62]	[0.33]	[0.34]	[0.70]	[0.26]	[0.00]
	(5) vs (7)	Difference	1.02***	0.22	4.24***	3.80***	4.67***	6.84***	0.18
			[0.00]	[0.77]	[0.00]	[0.00]	[0.00]	[0.03]	[0.49]
	(6) vs (7)	Difference	1.35***	0.57*	3.29***	2.53***	4.14***	1.54	0.74***
			[0.00]	[0.06]	[0.00]	[0.00]	[0.00]	[0.40]	[0.00]
Number of economies In sample	CPI		38	19	32	28	32	30	38
	PPI		38	20	29	23	29	28	38

CPI = consumer price index, GDP = gross domestic product, PPI = producer price index.
Notes: Economies in sample are listed in note to Table 1. High and low inflations refer to inflation higher than 10% and inflation less than 10%, respectively. Persistent deflations are defined the same as in Table 1. Difference for (1) vs (2) is calculated by subtracting the average per capita real GDP growth rate during the latter period, (1) from that during the former period, (2). Other differences are calculated similarly. Numbers in brackets are p-values and */**/*** denotes mean equality rejection with significance at the 10/5/1% level.
Sources: CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators.

Table 4 uses regression analysis to relate inflation/deflation to economic growth. Following Borio et al. (2015), we estimate panel regressions with country fixed effects, allowing differences across countries.[12] We include also the change in equity prices, as in Borio et al. (2015), to capture and control for separate effects of asset price deflation (which some argue is a greater problem than consumer price and producer price deflation). In the full sample, the coefficients on the change in both the CPI and the PPI are positive and highly significant, consistent with the idea that deflation is bad for economic growth. But for the CPI, all the explanatory power derives from the association of deflation with recession in the interwar period; the coefficients on the change in CPI inflation are positive and highly significant for this subperiod, but they do not approach statistical significance at conventional confidence levels for any other subperiod. This suggests that deflation was depressing during the Great Depression but not more generally, consistent with the findings of Borio et al. (2015).

The picture is different, however, for the PPI. Changes in the PPI are significantly related to growth, in the direction anticipated by the disruptive-deflation hypothesis, not just in the interwar period but also under the classical gold standard and since World War II, although the estimated coefficients are largest during the interwar period. This set of results also highlights the role of deflation in the Great Depression, but it is at odds with the view that deflation has been depressing only during the Great Depression.

In addition, including the change in equity prices and the interaction of the change in equity prices with a dummy variable for when that change is negative does not make the depressing effect of PPI deflation go away. It does confirm, however that falling equity prices make the resulting contraction of output worse.[13]

Restricting the sample to include only low inflation years (only years when inflation was less than 3% or, alternatively, less than 1%) does not change the results materially. The main difference from the baseline estimates is that the coefficient on the change in the CPI is now significantly positive at the 10% level or better under the gold standard (1870–1913) as well as in the interwar years, whereas there is no association of PPI inflation with growth under the gold standard.

[12] While the growth rate of per capita GDP can differ across countries of different levels of development, we believe that the country fixed effects also take care of this difference as well especially when we run the regression for the subsample period.

[13] That falling equity prices are depressing is consistent with the findings of Borio et al. (2015). That there is also a separate effect of deflation itself (when measured by the change in the PPI) is not.

Table 4: Output Growth and CPI and PPI Deflations II: Regression-Based Correlations

(a) No restrictions to inflation

	Full Sample				Classical Gold Standard (1870–1913)				Interwar (1920–1938)				Postwar (1947–2014)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ CPI	0.10***	0.10***			0.04	0.04			0.16***	0.15***			0.03	0.04		
	[0.024]	[0.023]			[0.073]	[0.076]			[0.029]	[0.028]			[0.029]	[0.028]		
Δ PPI			0.10***	0.10***			0.10*	0.10*			0.13***	0.13***			0.05**	0.06**
			[0.017]	[0.017]			[0.046]	[0.045]			[0.022]	[0.022]			[0.022]	[0.021]
Δ EP	0.01***	−0.00	0.01***	−0.01	0.02	0.01	−0.00	−0.02	0.08***	0.03	0.06***	0.00	0.00	−0.01	0.00	−0.01
	[0.004]	[0.006]	[0.004]	[0.006]	[0.019]	[0.034]	[0.015]	[0.014]	[0.011]	[0.022]	[0.011]	[0.019]	[0.003]	[0.006]	[0.003]	[0.006]
Δ EP^{def}		0.04***		0.04***		0.01		0.05		0.10**		0.10**		0.03**		0.03**
		[0.012]		[0.012]		[0.065]		[0.036]		[0.040]		[0.036]		[0.012]		[0.012]
Observations	2,311	2,311	2,217	2,217	371	371	332	332	295	295	293	293	1,645	1,645	1,592	1,592
R^2	0.044	0.053	0.069	0.078	0.007	0.007	0.032	0.036	0.250	0.267	0.237	0.256	0.005	0.013	0.017	0.025
Number of economies in sample	35	35	35	35	11	11	11	11	16	16	16	16	35	35	35	35

(b) Years of inflation less than 1%

	Full Sample				Classical Gold Standard (1870–1913)				Interwar (1920–1938)				Postwar (1947–2014)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ CPI	0.23***	0.22***			0.11*	0.11**			0.26***	0.26***			−0.56	−0.56		
	[0.055]	[0.052]			[0.052]	[0.046]			[0.081]	[0.081]			[0.393]	[0.402]		
Δ PPI			0.17***	0.17***			0.02	0.02			0.17***	0.16**			0.15***	0.15***
			[0.034]	[0.034]			[0.082]	[0.082]			[0.055]	[0.057]			[0.043]	[0.043]
Δ EP	0.04***	0.02	0.02***	0.01	0.03	0.03	0.03	0.02	0.09***	0.11**	0.07***	0.04	0.01	−0.00	0.01	0.01
	[0.008]	[0.020]	[0.006]	[0.010]	[0.026]	[0.090]	[0.029]	[0.066]	[0.012]	[0.051]	[0.019]	[0.045]	[0.010]	[0.020]	[0.006]	[0.013]
Δ EP^{def}		0.04		0.02		0.01		0.01		−0.03		0.04		0.02		0.00
		[0.030]		[0.016]		[0.141]		[0.074]		[0.077]		[0.063]		[0.028]		[0.018]
Observations	614	614	846	846	221	221	181	181	172	172	178	178	221	221	487	487
R^2	0.111	0.114	0.111	0.113	0.016	0.016	0.008	0.008	0.271	0.271	0.235	0.237	0.046	0.048	0.027	0.027
Number of economies in sample	31	31	33	33	11	11	11	11	16	16	16	16	31	31	33	33

continued on next page

Table 4 continued

(c) Years of Inflation Less Than 3%

	Full Sample				Classical Gold Standard (1870–1913)				Interwar (1920–1938)				Postwar (1947–2014)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Δ CPI	0.25***	0.25***			0.11*	0.11*			0.33***	0.32***			0.13	0.14		
	[0.048]	[0.047]			[0.053]	[0.052]			[0.086]	[0.082]			[0.206]	[0.209]		
Δ PPI			0.19***	0.18***			0.04	0.04			0.20***	0.19***			0.18***	0.18***
			[0.032]	[0.032]			[0.063]	[0.062]			[0.061]	[0.063]			[0.049]	[0.048]
Δ EP	0.02***	0.00	0.02***	0.00	0.01	0.00	0.01	−0.00	0.08***	0.05	0.07***	0.04	0.01***	−0.00	0.01**	−0.00
	[0.004]	[0.008]	[0.004]	[0.006]	[0.021]	[0.053]	[0.026]	[0.027]	[0.013]	[0.031]	[0.022]	[0.052]	[0.004]	[0.008]	[0.004]	[0.008]
Δ EP^{def}		0.04**		0.03***		0.03		0.04		0.04		0.05		0.03*		0.02*
		[0.014]		[0.012]		[0.091]		[0.029]		[0.051]		[0.069]		[0.013]		[0.013]
Observations	1,270	1,270	1,245	1,245	295	295	232	232	227	227	208	208	748	748	805	805
R^2	0.093	0.100	0.109	0.115	0.010	0.011	0.005	0.007	0.293	0.296	0.274	0.278	0.015	0.020	0.037	0.041
Number of economies in sample	33	33	35	35	11	11	11	11	16	16	16	16	33	33	35	35

CPI = consumer price index, PPI = producer price index.

Notes: The dependent variable is the log change of per capita real GDP, Δ CPI, Δ PPI, and Δ EP are, respectively, the log change in the CPI, the PPI, and stock prices. Δ CPI^{def}, Δ PPI^{def} and Δ EP^{def} are, respectively, the log changes interacted with a dummy variable that is equal to 1 when the respective price index declines and zero otherwise. Allowing for differences across countries, we include country fixed effects. Numbers in brackets are cluster-robust standard errors and */**/*** denotes significance at the 10/5/1% level.

Sources: Authors' calculation. CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators. The stock price data are from the Global Financial Database, Bloomberg, and Shularick and Taylor (2012).

Borio et al. (2015) also consider a second measure of asset price inflation, namely the change in property (housing) prices. When we include this variable along with the two measures of price-level inflation and the change in equity prices for the postwar period (the only period for which we have data on housing prices), the results suggest that asset price fluctuations matter more than price-level fluctuations for growth. Like Borio et al. (2015), we obtain a negative and significant coefficient on CPI inflation, inconsistent with the hypothesis of damaging deflation (Table 5.) In contrast, equity prices and property prices both matter, in general and even more when those changes are negative.

Table 5: Output Growth and CPI and PPI Deflations: Regression-Based Correlations (Postwar)

(a) No restrictions

	(1)	(2)	(3)	(4)	(5)	(6)
Δ CPI	−0.028**	−0.085***	−0.063**			
	[0.011]	[0.026]	[0.029]			
Δ PPI				−0.031**	0.002	−0.012
				[0.012]	[0.022]	[0.026]
Δ PP		0.169***	0.115***		0.154***	0.100***
		[0.016]	[0.012]		[0.014]	[0.012]
Δ EP		0.006**	−0.002		0.007**	−0.002
		[0.003]	[0.004]		[0.003]	[0.004]
Δ CPI^{def}			−0.078			
			[0.338]			
Δ PPI^{def}						0.168**
						[0.064]
Δ PP^{def}			0.237***			0.267***
			[0.054]			[0.058]
Δ EP^{def}			0.016**			0.017**
			[0.007]			[0.007]
Observations	2,498	1,058	1,058	2,321	1,031	1,031
R^2	0.008	0.241	0.275	0.011	0.230	0.283
Number of economies in sample	38	32	32	38	31	31

(b) Less than 1%

	(1)	(2)	(3)	(4)	(5)	(6)
Δ CPI	−0.133	−0.275	−0.254			
	[0.190]	[0.257]	[0.250]			
Δ PPI				0.112**	0.117***	0.125***
				[0.052]	[0.041]	[0.042]
Δ PP		0.278***	0.216*		0.179***	0.130***
		[0.037]	[0.119]		[0.036]	[0.030]
Δ EP		0.007	0.001		−0.001	0.010
		[0.008]	[0.013]		[0.004]	[0.013]
Δ PP^{def}			0.114			0.138*
			[0.187]			[0.079]
Δ EP^{def}			0.013			−0.019
			[0.020]			[0.019]
Observations	323	125	125	588	299	299
R^2	0.004	0.332	0.337	0.010	0.238	0.256
Number of economies in sample	37	25	25	38	29	29

continued on next page

Table 5 continued

(c) Less than 3%

	(1)	(2)	(3)	(4)	(5)	(6)
Δ CPI	0.114	0.181	0.156			
	[0.118]	[0.146]	[0.140]			
Δ PPI				0.130**	0.126***	0.136***
				[0.049]	[0.041]	[0.041]
Δ PP		0.201***	0.141***		0.188***	0.132***
		[0.019]	[0.027]		[0.024]	[0.024]
Δ EP		0.008***	0.003		0.005*	0.007
		[0.003]	[0.007]		[0.003]	[0.009]
ΔPP^{def}			0.170**			0.174**
			[0.064]			[0.064]
ΔEP^{def}			0.012			−0.004
			[0.014]			[0.016]
Observations	955	501	501	983	503	503
R^2	0.004	0.318	0.334	0.014	0.290	0.310
Number of economies in sample	38	29	29	38	31	31

CPI = consumer price index, PPI = producer price index.
Notes: The dependent variable is the log change of per capita real GDP. Δ CPI, Δ PPI, Δ PP and Δ EP are, respectively, the log change in the CPI, the PPI, property prices, and stock prices. ΔCPI^{def}, ΔPPI^{def}, ΔPP^{def}, and ΔEP^{def} are, respectively, the log changes interacted with a dummy variable that is equal to 1 when the respective price index declines and zero otherwise. */**/*** denotes significance at the 10/5/1% level. Numbers in brackets are cluster-robust standard errors.
Sources: Authors' calculation. CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators. Property prices are from the BIS residential property price database and the OECD analytical house price database. The stock price data are from the Global Financial Database, Bloomberg, and Shularick and Taylor (2012).

However, this negative result (negative coefficient) for price-level changes does not carry over when PPI inflation is considered, except in the limited specification where the change in PPI inflation is the sole explanatory variable. The full specification in column 6 suggests that the change in the PPI is significantly associated with output growth, in the expected way (deflation lowers growth), when we focus on periods of deflation. Changes in asset prices also matter, especially in deflationary periods, but they do not alter the foregoing finding.

When we restrict the sample so as to exclude high inflation years, as in panels b and c of Table 5, these conclusions come through still more clearly. The rate of inflation/deflation is strongly associated with the rate of GDP growth when inflation and deflation are measured by the PPI rather than the CPI. Asset prices also matter, but their inclusion does not modify the results.

Table 6 looks instead at peaks in the CPI and PPI, asking whether dips in one, the other or both are negatively associated with economic growth. We estimate a panel regression with country fixed effects. The dependent variable is $\left(y_{i,t+h} - y_{i,t}\right) - \left(y_{i,t} - y_{i,t-h}\right)$, $\mathrm{h} = 1, \ldots, 5$, where $y_{i,t}$ is the log level of per capita real GDP for country i at t. P^{CPI}, P^{PPI}, and P^{EP} are, respectively, the CPI, PPI, and property price peak dummies that take the value of 1 at peaks and zero otherwise. Estimates for the full sample period are consistent with the idea that the GDP growth rate is lower after peaks using both measures of the price level. The subsample results suggest that the full sample coefficient on the CPI peak is driven primarily by the Great Depression era, with its pronounced price-level peak in 1929. In contrast, it appears that growth in the modern (post-World War II) period is lower after price-level peaks than before when we consider the PPI instead of the CPI. Again, considering the PPI does not suggest that "it is all about the Great Depression."

Table 6: Change in Output Growth Following CPI, PPI, and Equity-Price Peaks

		(1) h=1	(2) h=2	(3) h=3	(4) h=4	(5) h=5
Full sample	P^{CPI}	−0.018*	−0.034***	−0.053**	−0.065**	−0.065**
	P^{PPI}	−0.013	−0.025**	−0.032***	−0.028**	−0.044***
	P^{EP}	−0.008***	−0.034***	−0.058***	−0.071***	−0.080***
	P^{CPI} alone	−0.008	−0.036***	−0.046**	−0.052*	−0.055**
	P^{PPI} alone	−0.012*	−0.026**	−0.034***	−0.037***	−0.053***
Classical gold standard	P^{CPI}	−0.009	−0.008	−0.022	−0.022	−0.012
	P^{PPI}	0.014	−0.006	−0.006	0.033	−0.004
	P^{EP}	−0.008	−0.027	−0.042**	−0.055**	−0.049**
	P^{CPI} alone	0.004	−0.013	−0.015	−0.008	−0.006
	P^{PPI} alone	0.005	−0.005	−0.018	−0.009	−0.026*
Interwar	P^{CPI}	−0.038***	−0.135***	−0.181***	−0.242***	−0.225***
	P^{PPI}	−0.007	−0.028	−0.037	−0.099**	−0.118***
	P^{EP}	−0.015	−0.058**	−0.140***	−0.191***	−0.208***
	P^{CPI} alone	−0.024	−0.110***	−0.154***	−0.213***	−0.200***
	P^{PPI} alone	0.004	−0.073**	−0.106**	−0.156***	−0.201**
Postwar	P^{CPI}	−0.043	−0.026	−0.032	−0.040	−0.038
	P^{PPI}	−0.020***	−0.035***	−0.045***	−0.041**	−0.044
	P^{EP}	−0.008***	−0.032***	−0.049***	−0.055***	−0.065***
	P^{CPI} alone	−0.047*	−0.029	−0.036*	−0.042*	−0.039
	P^{PPI} alone	−0.021***	−0.034***	−0.042***	−0.038**	−0.041

CPI = consumer price index, PPI = producer price index.

Notes: The dependent variable is $(y_{i,t+h} - y_{i,t}) - (y_{i,t} - y_{i,t-h})$, h = 1, … ,5, where $y_{i,t}$ is the log level of per capita real GDP for country *i* at *t*. P^{CPI}, P^{PPI}, and P^{EP} are, respectively, the CPI, PPI, and property price peaks. See note to Table 1 for the definition of CPI and PPI peaks. The Property price peak is defined similarly. P^{CPI} alone and P^{PPI} alone present the same regression results estimated over the same time and country sample with only the CPI peaks and PPI peaks, respectively. */**/*** denotes significance at the 10/5/1% level. Numbers in brackets are cluster-robust standard errors.

Sources: Authors' calculation. CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators. The stock price data are from the Global Financial Database, Bloomberg, and Shularick and Taylor (2012).

Finally, Table 7 looks directly at growth in years before and after price level peaks; in addition, it interacts the dummy variable for whether a year is after a price-level peak with measures of the change in property prices and stock prices. The dependent variable is $(y_{i,t+5} - y_{i,t}) - (y_{i,t} - y_{i,t-5})$. D is the government debt-to-GDP ratio (columns 3 and 4) and the private debt-to-GDP ratio (columns 5–8), where the private debt is measured by bank loans to the nonfinancial private sector. Both public and private debt ratios are detrended using a linear trend in columns 3–6. The private credit gap is detrended by using the two-sided Hodrick-Prescott filter in columns 7–8. The debt variables are interacted with the four peak dummies when used as regressors. The estimation period is limited to the modern era, reflecting our limited data on property prices. When the interaction terms are not included (columns 1 and 2), the coefficient on the CPI peak is positive but that on the PPI peak is negative. This pattern for the PPI is consistent with the idea that growth is lower after the price level peaks and goes into decline. Again we are alerted to the sensitivity of results to the particular measure of the price level considered. In addition, consistent with the argument that asset-price fluctuations also matter, growth is also significantly lower following property-price and stock-market peaks.

Table 7: Change in 5-Year Output Growth after CPI, PPI, Property-Price, and Equity-Price Peaks (Postwar)

			Public Debt Ratio		Private Debt Ratio		Private Credit Gap	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
P^{CPI}	0.013**		0.054***		0.008*		0.013***	
	[0.006]		[0.002]		[0.004]		[0.002]	
P^{PPI}		−0.061**		−0.060**		−0.023		−0.053
		[0.029]		[0.027]		[0.037]		[0.032]
P^{PP}	−0.087***	−0.088***	−0.084***	−0.085***	−0.063***	−0.063***	−0.047**	−0.044*
	[0.021]	[0.021]	[0.022]	[0.022]	[0.022]	[0.022]	[0.023]	[0.023]
P^{EP}	−0.066***	−0.068***	−0.070***	−0.070***	−0.067***	−0.066***	−0.063***	−0.063***
	[0.012]	[0.012]	[0.011]	[0.011]	[0.012]	[0.012]	[0.012]	[0.012]
$D*P^{CPI}$			−0.000***		0.058		0.138	
			[0.000]		[0.039]		[0.110]	
$D*P^{PPI}$				0.001*		−0.076**		0.176
				[0.000]		[0.035]		[0.263]
$D*P^{PP}$			0.000	0.001	−0.081**	−0.081**	−0.329**	−0.341**
			[0.001]	[0.001]	[0.039]	[0.037]	[0.142]	[0.144]
$D*P^{EP}$			0.001***	0.001***	−0.004	−0.015	−0.154	−0.172
			[0.000]	[0.000]	[0.027]	[0.027]	[0.149]	[0.154]
Observations	932	909	899	891	930	907	930	907
R^2	0.055	0.061	0.066	0.070	0.059	0.066	0.063	0.070
Number of groups	30	30	29	29	30	30	30	30

CPI = consumer price index, PPI = producer price index.

Notes: The dependent variable is $(y_{i,t+5} - y_{i,t}) - (y_{i,t} - y_{i,t-5})$, where $y_{i,t}$ is the log level of per capita real GDP for country i at t. P^{CPI}, P^{PPI}, P^{PP}, and P^{EP} are, respectively, the CPI, PPI, property price, and stock price peak dummies that take one at peaks and zero otherwise. See note to Table 1 for the definition of CPI and PPI peaks. The property price and stock price peaks are defined similarly. D is the government debt-to-GDP ratio (columns 3–4) and the private debt-to-GDP ratio (columns 5–8), where the private debt is measured by bank loans to the nonfinancial private sector. Both public and private debt ratios are detrended using a linear trend in columns 3–6. The private credit gap is detrended by using the two-sided Hodrick-Prescott filter in columns 7–8. The debt variables are interacted with the four peak dummies when used as regressors

Sources: Authors' calculation. CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators. Property prices are from the BIS residential property price database and the OECD analytical house price database. The stock price data are from the Global Financial Database, Bloomberg, and Shularick and Taylor (2012).

In columns 3–8, we interact these dummy variables for peaks with various measures of indebtedness as a more direct test of the debt-deflation hypothesis (although we would emphasize, echoing the discussion in this paper's introduction, that it is not only through debt deflation that falls in the price level can, in principle, be damaging).[14] When we distinguish public from private debt, the interaction term with the peak in the CPI is negative and significant in the case of public debt, but the coefficient on interaction term with the peak in the PPI is negative and significant in the case of private debt. We also find that the coefficient on the interaction term of the private debt with the peak in property price is negative and significant, suggesting that private debt makes property price deflations more costly. This is again consistent with the findings of Borio et al. (2015).

IV. WHAT ELSE IS SPECIAL ABOUT THE POST-WORLD WAR II PERIOD?

Long historical time series as analyzed here have the advantage of highlighting what if anything is distinctive about the deflation–growth nexus in the modern world. But the post-World War II period (which is what most previous analysts have meant by "the modern world" in practice) is also special, potentially, in other regards. Compared to the classical gold standard and interwar eras that preceded this modern period, modern economic growth had preceded for longer in some parts of the world. This made for different initial conditions—different levels of per capita GDP—which created scope for different rates of catch-up growth. As is well known, not only do late-developing catch-up economies grow relatively fast (as a matter of definition), but they also tend to experience relative high rates of inflation (due to the operation of the Balassa-Samuelson effect). Thus, not controlling for these initial conditions may have implications for the observed correlation between deflation and growth in general, and in the post-World War II period in particular.

In addition, the immediate aftermath of World War II was marked by exceptional swings between inflation and deflation (in the US, the rate of CPI inflation swung from 1.4% in 1947 to –1.2% in 1949 and 7.9% in 1951). Output recovered strongly not so much because of any influence of inflation or deflation on expectations but because of the removal of wartime price controls, the elimination of postwar production ceilings on key industries (as in Germany) and the repair of wartime damage.

Table 8 shows how the results change when we control for these effects, eliminating the subperiod 1946–1949 and controlling for per capita GDP. Table 8.a presents the results when the growth rate of real GDP per capita for country i at time t, y_{it}, is regressed on a low CPI (PPI) inflation dummy, d_{it}^{L}, and a high CPI (PPI) inflation dummy, d_{it}^{H}.

$$y_{it} = \beta_0 + \gamma_1 d_{it}^{L} + \gamma_2 d_{it}^{H} + \varepsilon_{it}$$

The constant term, β_0, in these regressions is the average rate of growth of per capita GDP in deflation years, whereas the rate of growth in years of low (high) inflation is the sum of the constant, β_0, and the coefficient on the low (high) inflation dummy variable, d_{it}^{L} (d_{it}^{H}).[15] We report regression results based on pooled ordinary least squares and panel estimates with fixed effects.

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[14] Fisher (1933) developed a debt-deflation theory of Great Depression where a fall in the level of prices decreases net worth of business, by increasing the value of nominal debts, causing decreases in investment. While it would be desirable to investigate the role of debt deflation based on its impact on investment, since investment data for the historical period are not generally available, we use the growth rate of per capita real GDP as a dependent variable. We believe that if debt deflation decreases investment, it will also decrease the growth rate of GDP as well.

[15] This interpretation is possible since we adjust y_{it} by subtracting from it the mean growth rate of per capita real GDP in deflation years.

Table 8: CPI and PPI Deflations and Average Real GDP Growth Rate

(a) Current income not controlled

	Full Sample				Classical Gold Standard				Interwar			
	CPI		PPI		CPI		PPI		CPI		PPI	
	Pooled	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect
Constant	1.17***	1.23***	1.40***	1.38***	1.17***	1.20***	1.29***	1.28***	0.36	0.24	0.42	0.27
	[0.160]	[0.226]	[0.130]	[0.159]	[0.273]	[0.299]	[0.219]	[0.281]	[0.360]	[0.353]	[0.389]	[0.295]
Low inflation	1.57***	1.49***	1.35***	1.37***	0.43	0.37	0.57*	0.59	3.34***	3.58***	3.29***	3.72***
	[0.181]	[0.279]	[0.161]	[0.207]	[0.371]	[0.472]	[0.308]	[0.505]	[0.533]	[0.709]	[0.627]	[0.734]
High inflation	1.14***	1.07***	1.02***	1.08***	0.00	−0.11	0.22	0.14	2.67***	2.90***	4.24***	4.27***
	[0.226]	[0.375]	[0.201]	[0.359]	[0.912]	[2.084]	[0.718]	[1.336]	[0.824]	[0.962]	[0.945]	[0.893]
Observations	3,583	3,583	3,333	3,333	603	603	601	601	511	511	440	440
R-squared	0.020	0.019	0.021	0.022	0.002	0.002	0.006	0.006	0.076	0.085	0.080	0.096

	Postwar							
	CPI				PPI			
	Pooling		Fixed Effect		Pooling		Fixed Effect	
	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950
Constant	2.55***	2.00***	2.05***	1.39***	2.10***	2.08***	1.80***	1.82***
	[0.294]	[0.298]	[0.498]	[0.397]	[0.173]	[0.169]	[0.169]	[0.170]
Low inflation	0.27	0.81***	0.76	1.44***	0.74***	0.71***	1.06***	1.01***
	[0.306]	[0.309]	[0.543]	[0.425]	[0.197]	[0.192]	[0.204]	[0.197]
High inflation	−0.27	0.05	0.40	0.76*	0.18	0.01	0.65**	0.36
	[0.329]	[0.331]	[0.532]	[0.438]	[0.223]	[0.220]	[0.283]	[0.278]
Observations	2,469	2,345	2,469	2,345	2,292	2,177	2,292	2,177
R-squared	0.004	0.010	0.004	0.014	0.009	0.011	0.013	0.016

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Table 8 continued

(b) Current income controlled I

	Full Sample				Classical Gold Standard				Interwar			
	CPI		PPI		CPI		PPI		CPI		PPI	
	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect
Constant	1.17***	1.22***	1.41***	1.36***	1.17***	1.24***	1.29***	1.36***	0.36	0.54	0.42	0.41
	[0.159]	[0.227]	[0.130]	[0.158]	[0.272]	[0.270]	[0.219]	[0.269]	[0.360]	[0.370]	[0.389]	[0.355]
Low inflation	1.90***	1.73***	1.44***	1.49***	0.37	0.02	0.54*	0.31	3.35***	3.14***	3.30***	3.59***
	[0.193]	[0.330]	[0.163]	[0.212]	[0.372]	[0.440]	[0.308]	[0.483]	[0.533]	[0.708]	[0.628]	[0.773]
High inflation	1.30***	1.26***	1.02***	1.17***	0.23	0.02	0.32	0.12	2.61***	3.25***	4.14***	4.40***
	[0.228]	[0.399]	[0.201]	[0.346]	[0.921]	[2.100]	[0.719]	[1.270]	[0.829]	[0.989]	[0.960]	[0.864]
Per capita GDP	−0.41***	−0.29**	−0.25***	−0.28**	0.67	4.36***	0.51*	2.63***	−0.26	8.51***	−0.36	4.34
	[0.084]	[0.124]	[0.079]	[0.105]	[0.412]	[1.318]	[0.286]	[0.372]	[0.435]	[2.357]	[0.586]	[3.546]
Observations	3,583	3,583	3,333	3,333	603	603	601	601	511	511	440	440
R-squared	0.027	0.022	0.024	0.025	0.007	0.029	0.011	0.022	0.076	0.114	0.081	0.106

	Postwar							
	CPI				PPI			
	Pooling Regression		Fixed Effect		Pooling Regression		Fixed Effect	
	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950
Constant	2.55***	2.08***	2.16***	1.61***	2.10***	2.11***	1.59***	1.66***
	[0.288]	[0.292]	[0.478]	[0.398]	[0.170]	[0.166]	[0.171]	[0.174]
Low inflation	0.80***	1.27***	1.28**	1.80***	0.68***	0.65***	1.06***	1.01***
	[0.304]	[0.306]	[0.485]	[0.415]	[0.193]	[0.188]	[0.197]	[0.194]
High inflation	−0.28	−0.00	0.57	0.84*	−0.40*	−0.54**	0.31	0.12
	[0.322]	[0.324]	[0.486]	[0.415]	[0.227]	[0.224]	[0.252]	[0.267]
Per capita GDP	−0.95***	−0.92***	−1.34***	−1.16***	−0.92***	−0.88***	−1.49***	−1.37***
	[0.093]	[0.091]	[0.305]	[0.268]	[0.096]	[0.096]	[0.311]	[0.297]
Observations	2,469	2,345	2,469	2,345	2,292	2,177	2,292	2,177
R-squared	0.045	0.052	0.049	0.048	0.047	0.048	0.066	0.059

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Table 8 continued

(c) Current income controlled II

	Full Sample				Classical Gold Standard				Interwar			
	CPI		PPI		CPI		PPI		CPI		PPI	
	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect	Pooling	Fixed Effect
Constant	1.17***	1.22***	1.40***	1.35***	1.17***	1.25***	1.29***	1.36***	0.36	0.54	0.42	0.41
	[0.159]	[0.225]	[0.130]	[0.159]	[0.272]	[0.249]	[0.219]	[0.261]	[0.358]	[0.345]	[0.389]	[0.359]
Low inflation	1.84***	1.70***	1.42***	1.48***	0.41	0.06	0.54*	0.32	3.34***	3.12***	3.28***	3.58***
	[0.197]	[0.327]	[0.166]	[0.229]	[0.374]	[0.430]	[0.308]	[0.480]	[0.529]	[0.694]	[0.629]	[0.777]
High inflation	1.45***	1.30**	1.04***	1.18***	0.14	−0.06	0.72	0.60	3.31***	4.05***	3.93***	4.39***
	[0.246]	[0.489]	[0.201]	[0.353]	[1.029]	[1.441]	[0.755]	[1.272]	[0.875]	[0.846]	[1.045]	[0.836]
Per capita GDP	−0.50**	−0.44	−0.13	−0.26*	1.22*	5.56***	0.27	2.44***	−1.37**	7.49***	−0.57	4.30
	[0.220]	[0.289]	[0.138]	[0.147]	[0.648]	[1.394]	[0.442]	[0.645]	[0.626]	[2.173]	[0.772]	[3.263]
Per capita GDP * Low	0.17	0.19	−0.06	0.03	−0.95	−1.70*	0.22	0.05	1.69*	1.35	1.01	0.17
	[0.241]	[0.304]	[0.174]	[0.183]	[0.867]	[0.890]	[0.592]	[0.861]	[0.901]	[1.243]	[1.348]	[1.335]
Per capita GDP * High	−0.26	0.03	−0.66**	−0.32	−0.81	−1.18	2.24*	2.47	4.62***	4.74**	−0.54	0.02
	[0.326]	[0.507]	[0.264]	[0.269]	[1.563]	[2.863]	[1.281]	[1.636]	[1.668]	[2.294]	[1.754]	[1.825]
Observations	3,583	3,583	3,333	3,333	603	603	601	601	511	511	440	440
R-squared	0.028	0.022	0.026	0.025	0.009	0.035	0.016	0.028	0.092	0.128	0.083	0.106

	Postwar							
	CPI				PPI			
	Pooling Regression		Fixed Effect		Pooling Regression		Fixed Effect	
	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950	Since 1946	Since 1950
Constant	2.55***	2.11***	2.15***	1.64***	2.10***	2.13***	1.59***	1.69***
	[0.287]	[0.292]	[0.464]	[0.396]	[0.169]	[0.165]	[0.156]	[0.162]
Low inflation	0.71**	1.21***	1.23**	1.75***	0.70***	0.63***	1.07***	0.99***
	[0.305]	[0.309]	[0.455]	[0.400]	[0.193]	[0.188]	[0.184]	[0.185]
High inflation	−0.28	−0.02	0.57	0.79*	−0.36	−0.42*	0.49*	0.35
	[0.322]	[0.325]	[0.462]	[0.407]	[0.259]	[0.253]	[0.258]	[0.276]
Per capita GDP	−1.51***	−1.23***	−1.95***	−1.55***	−1.46***	−1.48***	−1.95***	−1.88***
	[0.277]	[0.276]	[0.444]	[0.377]	[0.202]	[0.201]	[0.356]	[0.346]
Per capita GDP * Low	0.70**	0.37	0.73*	0.43	0.73***	0.76***	0.58***	0.63***
	[0.297]	[0.295]	[0.379]	[0.348]	[0.237]	[0.236]	[0.205]	[0.217]
Per capita GDP * High	0.23	0.22	0.55	0.59	0.61**	0.85***	0.78**	1.01***
	[0.366]	[0.365]	[0.473]	[0.391]	[0.300]	[0.303]	[0.289]	[0.333]
Observations	2,469	2,345	2,469	2,345	2,292	2,177	2,292	2,177
R-squared	0.048	0.052	0.051	0.050	0.051	0.053	0.069	0.064

CPI = consumer price index, GDP = gross domestic price, PPI = producer price index.

Notes: The dependent variable is the log change of per capita real GDP. The regressors are low-inflation, high-inflation dummy variables and log per capita real GDP. The low-inflation dummy takes 1 if the respective price inflation is higher than 0% and less than 10%, and zero otherwise. The high-inflation dummy takes 1 when the respective inflation is higher than 10% and less than 100%, and zero otherwise. Numbers in brackets are cluster-robust standard errors and */**/*** denotes significance at the 10/5/1% level.

Sources: Authors' calculation. CPI and PPI are from Global Financial Database, International Historical Statistics 1750–2010 and International Financial Statistics, and per capita real GDP, from the Maddison Project and World Development Indicators.

The pooled ordinary least squares estimation results yield identical results to those reported in Table 3. In the first column, for example, a constant term is estimated to be 1.17, which is exactly the same as the average growth rate in deflation years for the full sample reported in Table 3. We can also retrieve the average growth rate in low inflation years by adding the estimated coefficient of the low inflation dummy, 1.57, to 1.17 (=2.74). Similarly, the average growth rate in high inflation years is obtained by adding the estimated coefficient of the high inflation dummy, 1.17, to 1.17 (=2.31). Note that, for the postwar period, the estimated coefficient of the low inflation dummy is 0.27 (in pooled regression) or 0.76 (in panel regression) and is not statistically significant, which suggests that the average growth rate in low CPI inflation years is not significantly different from that in CPI deflation years. However, if we estimate the same equation using data since 1950, the estimated coefficient of the low inflation dummy is 0.81 (in pooled regression) or 1.44 (in panel regression) and it is statistically significant at the 1% level. Hence the average growth rate in CPI deflation years is significantly lower than that in low-inflation years if we eliminate the 1946–1949 period. The PPI results, however, are not sensitive to the elimination of the subperiod 1946–1949. The coefficient of the low inflation dummy is always positive and statistically significant at conventional confidence levels.

In Table 8.b and Table 8.c, we control for per capita GDP, by adding log per capita GDP, $pcGDP_{it}$, as an additional regressor. In Table 8.b, we report estimation results where per capita GDP is simply added as follows:

$$y_{it} = \beta_0 + \gamma_1 d_{it}^L + \gamma_2 d_{it}^H + \beta_1 pcGDP_{it} + \varepsilon_{it}$$

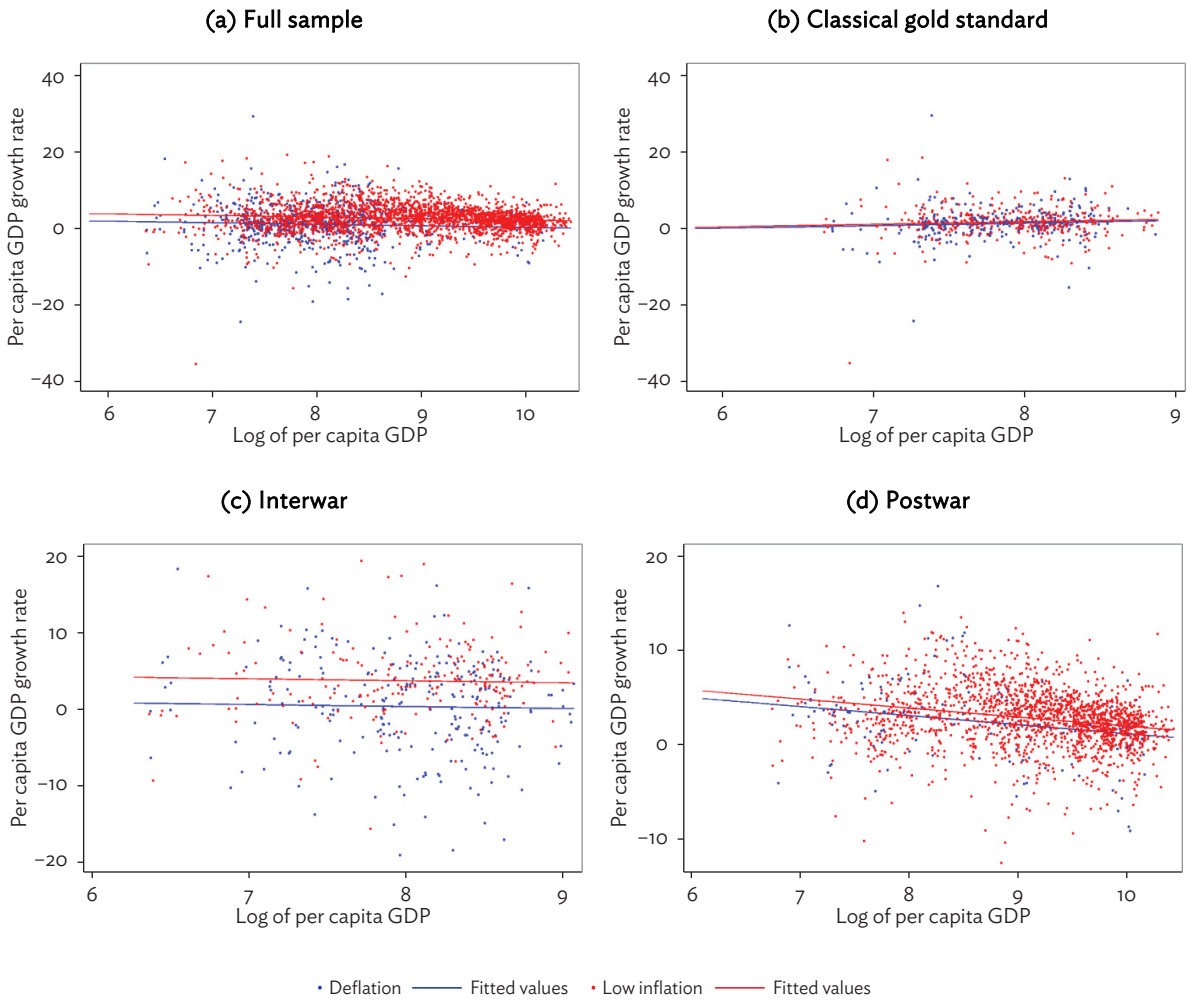
In Table 8.c, we also allow the coefficient of $pcGDP_{it}$ to differ across deflation, low-inflation and high-inflation years as follows:

$$y_{it} = \beta_0 + \gamma_1 d_{it}^L + \gamma_2 d_{it}^H + (\beta_1 + \beta_2 d_{it}^L + \beta_3 d_{it}^H) pcGDP_{it} + \varepsilon_{it}$$

In both Table 8.b and Table 8.c, per capita GDP registers significantly, with the expected negative sign (low per capita income countries with scope for catch-up grow faster, other things equal) in all the full sample regressions and the vast majority of subperiod regressions. Now for the post-World War II period, we find significantly slower growth in periods of deflation than in periods of low inflation: the coefficient of low inflation dummy is positive and statistically significant for both CPI and PPI. This is true in both the pooled regressions and in the regressions including fixed effects. It is true, so long as we include per capita GDP as a control, whether or not the sample includes 1946–1949, although the difference is larger when we exclude the first four postwar years.

In Figure 1, we plot the growth rate of real GDP per capita against per capita GDP, denoting red dots as CPI low inflation years and blue dots as CPI deflation years. The fitted lines are derived from Table 8.b where the coefficient of per capita GDP is assumed to be the same across CPI deflation and CPI low inflation years. Generally, blue dots are located lower, which explains why the fitted line for deflation years is located below the red line. However, the variance is larger for blue dots, indicating that the real GDP growth rate is more diverse in deflation years.

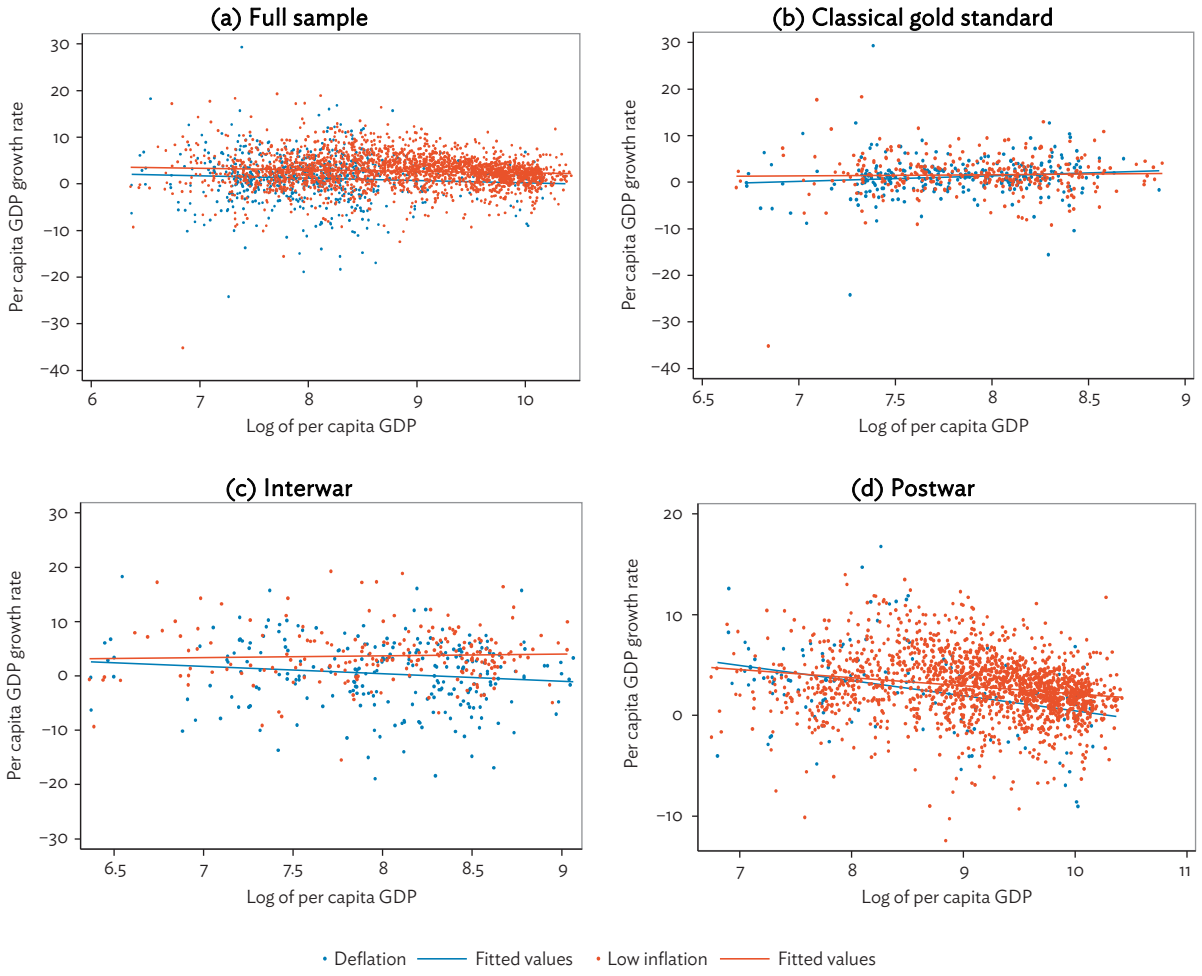
Figure 1: Current Income and Average Log of Real GDP Growth Rate during Deflation and Low Inflation: The Same Slope I



GDP = gross domestic product.
Notes: We plot the growth rate of real GDP per capita against per capita GDP, denoting red dots as CPI low inflation years and blue dots as CPI deflation years. The fitted lines are derived from Table 8.b where the coefficient of per capita GDP is assumed to be the same across CPI deflation and CPI low inflation years.
Source: Authors' calculations.

Figure 2 is the same as Figure 1 except that the coefficient of per capita GDP (the slope) is allowed to differ across CPI deflation and CPI low-inflation years. Interestingly, the gap between the two fitted lines of deflation and low-inflation years gets wider as per capita GDP increases. This indicates that CPI deflation can be worse in high-income countries than in low-income countries.

Figure 2: Current Income and Average Log of Real GDP Growth Rate during Deflation and Low Inflation: Different Slopes



GDP = gross domestic product.
Notes: We plot the growth rate of real GDP per capita against per capita GDP, denoting red dots as CPI low inflation years and blue dots as CPI deflation years. The fitted lines are derived from Table 8.c where the coefficient of per capita GDP (the slope) is allowed to differ across CPI deflation and CPI low-inflation years.
Source: Authors' calculations.

V. TENTATIVE CONCLUSIONS

To the question posed in the title of this paper (can the danger of deflation be dismissed?), our answer is "not yet." Long-run historical comparisons do not rule out the possibility that deflation is negatively associated with economic growth—or, if one is prepared to hazard a causal interpretation, that deflation depresses growth. The inflation and deflation relevant to agents is notoriously difficult to measure. Tautologically, changes in the CPI will be relevant to consumers, while changes in the PPI will be relevant to producers, and it is not obvious, a priori, whether the behavior of producers or consumers is more immediately relevant in particular episodes of deflation. Prudence recommends considering both, as we have done in this paper. And when we consider both, evidence on the question posed by our title is decidedly mixed.

The CPI yields very few episodes of persistent deflation in the post-World War II period, complicating efforts to conclusions about the potential effects of persistent deflation since the middle of the 20th century. There are more such episodes in the interwar period and the Great Depression in particular, causing CPI-based measures to suggest that the disruptive output effects of deflation are primarily a Great Depression-related phenomenon.

By comparison, PPI inflation is more volatile, including in the downward direction. There are more episodes of persistent deflation, including since the middle of the 20th century, when we use a PPI-based measure. According to our findings, changes in the PPI are significantly related to growth, in the direction anticipated by the disruptive-deflation hypothesis, not just in the interwar period but also and since World War II and possibly also under the classical gold standard, although the estimated effects are largest during the interwar period.[16] This set of results also highlights the role of deflation in the Great Depression, but it is at odds with the view that deflation has been depressing only during the Great Depression. It does not overturn previous work that asset-price booms and slumps are important, but controlling for those booms and slumps does not alter our conclusions about the potential dangers of deflation.

Drawing strong conclusions from the post-World War II period—including negative conclusions about the absence of an association between CPI deflation and slow growth—may also be hazardous because of other special characteristics of this period. The immediate postwar years are marked by sharp swings between inflation and deflation and unusual spurts in economic growth as wartime controls are lifted and damage due to hostilities is repaired. Differences in levels of per capita GDP and therefore differences in the scope for catch-up growth are also greater in the second half of the 20th century and initial years of the 21st than in the interwar and classical gold standard years; failing to controls for these differences may also have unintended consequences for the results. In particular, we show that omitting the second half of the 1940s from the sample and controlling for per capita GDP (and hence for the scope for catch-up growth provides stronger evidence that CPI as well as PPI deflation has been negatively associated with economic growth in the post-World War II period.

It is important to acknowledge that high inflation as well as deflation can have a negative impact on economic growth, since this fact comes through clearly in the raw data, especially in the period since World War II. In addition, when we exclude episodes of high inflation, the negative association between not just PPI deflation but also CPI deflation and growth comes through more clearly.

In fact, inflation was the much larger concern in developing Asia until the recent emergence of deflation, especially producer price deflation, in some countries. In particular, producer prices have declined for 47 consecutive months as of February 2016 in the PRC, against the backdrop of a tangible moderation in economic growth since the global financial crisis. Our evidence suggests that it would be prudent for the region's monetary authorities to keep an eye on producer prices as well as consumer prices.

Again, analysis of correlations between deflation and growth in aggregate time series like those considered here will never definitively answer the question of whether the danger of deflation can be dismissed. But our analysis suggests, to paraphrase Mark Twain, reports of its demise have been greatly exaggerated.

[16] Another caveat is that PPI inflation/deflation is significantly related to economic growth under the classical gold standard only at lower levels of confidence and only according to some specifications.

APPENDIX

Table A.1: Data Availability

Economy	Per Capita Real GDP	CPI	PPI	Stock Price	Property Price	Public Debt	Private Credit
Argentina	1875	1871	1914	1966	–	1870	1981
Australia	1870	1871	1902	1875	1970	1870	1873–1939; 1953
Austria	1870	1871	1871–1909; 1923	1922	2000	1880–1913; 1924–1937; 1948	1960
Belgium	1870	1871	1871	1897	1970	1870	1970
Brazil	1870	1871	1938	1992	2008	1870	1948–1949; 1988
Canada	1870	1871	1871	1915	1970	1870	1871
Chile	1870	1871	1929	1894	2002	1870	1962
PRC	1929–1938; 1950	1971	1997	1990	2010	1982	1985
Colombia	1870	1871	1949	1927	1988	1899	1950
Denmark	1870	1871	1877	1914	1970	1880	1885–1938; 1951
Finland	1870	1917	1914	1912	1970	1914	1950
France	1870	1871	1871	1870	1970	1880–1931; 1949	1870–1938;1950
Germany	1870	1871	1871	1870	1970	1880–1913; 1925–1938; 1951	1883–1913; 1925–1939; 1051
Greece	1870	1915	1930	1952	1997	1870–1939; 1950	1953
Hong Kong, China	1950	1948	1994	1964	1979	–	1978
Ireland	1921	1923	1939	1934	1970	1924	1948
Italy	1870	1871	1871	1870	1970	1870	1870–1939; 1951
Japan	1870	1871	1871	1914	1970	1872–1940; 1954	1888–1939; 1953
Republic of Korea	1911	1913–1938; 1949	1931	1962	1975	1913–1938; 1970	1962
Malaysia	1911	1949	1987	1973	1988	1949–1957; 1970	1964
Mexico	1895	1887	1887	1930	2005	1872	1948
The Netherlands	1870	1871	1902	1890	1970	1870	1900
New Zealand	1870	1908	1892	1926	1970	1870	1948
Norway	1870	1871	1892	1914	1970	1880	1870
Peru	1870	1901	1914	1926	–	1883	1980
Philippines	1902	1900	1936	1952	–	1948	1948
Portugal	1870	1931	1928	1931	1988	1870	1960
Singapore	1900–1939; 1950	1949	1975	1965	–	1970	1963
South Africa	1870	1896	1911	1910	1970	1870	1965
Spain	1870	1871	1871	1874	1971	1870	1900
Sweden	1870	1871	1871	1870	1970	1870	1871–1938; 1950
Switzerland	1870	1881	1871	1910	1970	1880–1913; 1929	1906
Thailand	1950	1949	1939	1992	1991	1913	1950
Turkey	1923	1871	1931	1996	2010	1870	1986
United States	1870	1871	1871	1870	1970	1870	1896
United Kingdom	1870	1871	1871	1870	1970	1870	1880
Uruguay	1870	1871	1964	–	–	–	1956
Venezuela	1870	1901	1871	1929	–	1914	1950

GDP = gross domestic product, CPI = consumer price index, PPI = producer price index, PRC = People's Republic of China.
Source: Authors' compilation.

Table A.2: Price Peaks

Economy	CPI	PPI	Stock Price	Property Price
Argentina	1920	1920, 1996		
Australia	1873, 1882, 1890, 1902, 1920, 1929	1902, 1908, 1919	1888, 1928, 1950, 1969, 2007	
Austria	1884,1891, 1929	1871, 1891, 1924, 1985, 1994	1975, 1989, 2006	
Belgium	1883, 1929	1873, 1881, 1891, 1926, 1951, 1957, 1984	1899, 1928, 1946, 1964, 1972, 1998, 2006	1980
Brazil	1927		2007	
Canada	1874, 1882, 1920, 1929	1873, 1890, 1919, 1951	1928, 1972, 2007	1994
Chile			1995	
PRC	1997	2004	2000, 2007	
Colombia	1928		1997	
Denmark	1874, 1891, 1901, 1920	1877, 1891, 1920, 1951	1919, 1927, 1946, 1965, 1972, 2007	1986, 2007
Finland	1928	1920, 1927, 1951	1919, 1927, 1973, 1988, 1999, 2007	1989
France	1871, 1877, 1884, 1901, 1930	1873, 1890, 1925, 1951	1881, 1890, 1899, 1928, 1962, 1972, 1999, 2007	1991
Germany	1874, 1881, 1891, 1928	1873, 1889, 1928, 1997	1872, 1881, 1889, 1899, 1928, 1946, 1960, 1969, 1999, 2007	1983, 1995
Greece	1927		1999, 2007	2008
Hong Kong, China	1997	1995	1972, 1999, 2007	1981, 1997
Ireland	1924	2000	2006	2007
Italy	1874, 1891, 1926	1874, 1890, 1900, 1925, 1948, 2007	1872, 1886, 1906, 1924, 1961, 1969, 1986, 2000, 2006	1993, 2008
Japan	1881, 1920, 1998, 2008	1881, 1919, 1956, 1982, 2008	1919, 1960, 1972, 1989, 1999, 2006	1991
Republic of Korea	1920		1999	1991
Malaysia		2007	1983, 1993	1997
Mexico		1889, 1920, 1927		
The Netherlands	1877, 1891, 1920	1919, 1951	1890, 1898, 1919, 1928, 1947, 1968, 1999, 2007	1978, 2008
New Zealand	1920	1893, 1898, 1906, 1920	1972, 1986, 1996, 2006	
Norway	1874, 1891, 1900, 1920	1893, 1900, 1920	1919, 1957, 1973, 2007	1988
Peru	1920	1920		
Philippines	1946	1948, 2008		
Portugal		1928, 1952	1989, 1999, 2007	2007
Singapore		1980	1983, 1993, 1999, 2007	
South Africa	1902, 1920	1920		
Spain	1882, 1898, 1920	1877, 1907, 1920	1882, 1889, 1900, 1927, 1947, 1956, 1973, 2007	2007
Sweden	1874, 1891, 1920	1873, 1891, 1900, 1919	1872, 1906, 1919, 1928, 1999, 2006	1991
Switzerland	1882, 1892, 1898, 1919	1873, 1890, 1919, 1951, 1974, 1992, 2008	1919, 1928, 1961, 1972, 1986, 2000, 2006	1989
Thailand			1993	1997
Turkey	1929			
United States	1872, 1881, 1891, 1920	1872, 1919	1872, 1881, 1892, 1928, 1972, 1999, 2007	2007
United Kingdom	1873, 1891, 1898, 1920	1872, 1919	1873, 1898, 1928, 1946, 1972, 1999, 2007	1989, 2007
Uruguay	1931			
Venezuela		1872, 1890, 1920, 1926		

GDP = gross domestic product, CPI = consumer price index, PPI = producer price index, PRC = People's Republic of China.
Source: Authors' compilation.

Table A.3: Data Sources

Variables	Sources	Economies/Years
CPI	International Historical Statistics	People's Republic of China (1971~1979), Greece (1915~1922), Republic of Korea (1913~1938), New Zealand (1908~1914), Philippines (1942~1943).
	International Financial Statistics, IMF	Colombia (2008~2009).
	Global Financial Database	All other years, all other countries.
PPI	International Historical Statistics	Austria (1870~1923), Belgium (1870~1913), Finland (1913~1920), Germany (1921~1923), Greece (1947~1948), Ireland (1939~1945), Italy (1870~1910, 1913~1914), New Zealand (1891~1913), Norway (1892~1977), Peru (1913~1980), Portugal (1928~1932), Thailand (1939~1947), Uruguay (1963~1966).
	Global Financial Database	All other years, all other countries.
Equity prices	Shularick and Taylor (2012)	Canada (1915~1991), France (1994~2008), Germany (1870~1917), Italy (1870~1904), The Netherlands (1890~1918), Norway (1914~1968), Spain (1874~1984), Sweden (1870~1900).
	Bloomberg	France (2009~2014), Portugal (2007~2014), Venezuela (2006~2014).
	Global Financial Database	All other years, all other countries.
Property prices	Residential property price statistics, BIS	Hong Kong, China; Republic of Korea; Malaysia; Thailand.
	OECD	All other years, all other countries.
Real GDP per capita	World Development Indicators	2011~2014
	Maddison project	All other years, all other countries.
Government debt	Carmen Reinhart; Total (domestic plus external) gross general government debt/GDP	Italy, The Netherlands, New Zealand.
	World Economic Outlook (IMF)	2011~2014
	Carmen Reinhart; Total (domestic plus external) gross central government debt/GDP	All other years, all other countries.
Private credit	Shularick and Taylor (2012); Credit to the nonfinancial sector, BIS	Australia, Canada, Denmark, France, Germany, Italy, Japan, The Netherlands, Norway, Spain, Sweden, Switzerland, United States, United Kingdom.
	International Financial Statistics, IMF; Credit to the nonfinancial sector, BIS	Argentina, Brazil, Chile, Colombia, Finland, Greece, Ireland, Mexico, New Zealand, Peru, Philippines, Singapore, Thailand, Uruguay, Venezuela.
	Credit to the nonfinancial sector, BIS	Austria; Belgium; People's Republic of China; Hong Kong, China; Republic of Korea; Malaysia; Portugal; South Africa; Turkey.

BIS = Bank for International Settlements, CPI = consumer price index, GDP = gross domestic price, IMF = international Monetary Fund, OECD = Organisation for Economic Co-operation and Development, PPI = producer price index.
Source: Authors' compilation.

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Deflation in Asia: Should the Dangers Be Dismissed?

Deflation has emerged as a new concern for Asian policy makers. The traditional view is that deflation can lead to a vicious cycle of falling demand and prices. However, another school of thought emphasizes the role of positive supply shocks and takes a more benign view. Using consumer prices, Borio et al. (2015) examine the relationship between deflation and economic growth, and find some evidence which casts doubt on the traditional view. Using both consumer prices and producer prices, the authors revisit the relationship and find stronger grounds for concern about the harmful effect of deflation on growth.

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