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The U.S. Miracle

(This analysis is based on data released prior to the July 2001 historical revision to the National Accounts)

Introduction

From 1996 to the middle of 2000, real GDP in the United States grew, on average, by about 4 1/2 per cent per year, a rate above most estimates of sustainable growth.[1] Still, inflationary pressures, as measured by the year-over-year rate of change in the CPI excluding food and energy, remained subdued over the period. Many analysts argued that this unusual combination of developments, often referred to as the U.S. miracle, reflected an acceleration in potential output brought about by a boom in investment, and especially in information technology (IT) investment, which led to a rise in productivity growth.

Using a simple accounting framework, this note will first assess the factors that have contributed to the acceleration in labour productivity over the period. Second, it will describe the methodology used at the Bank of Canada to measure U.S. potential GDP. The analysis will show that the rise in labour productivity growth in the second half of the 1990's reflects an acceleration in total factor productivity growth and a shift toward more IT capital intensive production. As a result, the rate of growth of U.S. potential GDP is estimated to have averaged close to 3 3/4 per cent per year over 1995-2000, an increase of about one percentage point from the estimated long-run rate of growth of 2 3/4 per cent.

Accounting for the growth in labour productivity

Using the neoclassical theory of growth, the growth rate of labour productivity is the sum of the growth rate of total factor productivity, and the change in the capital/labour ratio as described in equation (1). In addition, the rate of growth of the composition of labour measures the effect on labour productivity of the change in the quality of the work force.

$$\Delta\log\left(\frac{y}{h}\right) = \Delta\log(tfp) + s_k\Delta\log\left(\frac{k}{h}\right) + s_l\Delta\log(lc) \qquad (1)$$

where y is the level of production,
h, total hours worked,
tfp, total factor productivity,
k, the services derived from the capital stock[2],
s_k, the share of capital,

1. This note concentrates on the structural developments in the United States during the 1990's and abstracts from the cyclical slowing in growth since the second half of 2000.

s_l, the share of labour,
lc, the composition of labour[3],
and $\Delta \log(x)$ stands for the first difference of the logarithm of variable x.

As shown in Figure 1, short-term variations in labour and total factor productivity are usually in the same direction. However, over the historical period, growth in labour productivity has been higher, on average, than that of total factor productivity because of a rise in the capital/labour ratio and an increase in workers' human capital (see Figure 2). Indeed, a change in labour productivity reflects the variation in production that cannot be accounted for by a variation in the hours worked whereas a change in total factor productivity measures the change in production that is not explained by a change in factor inputs (capital and labour). Total factor productivity is designed to measure the joint influence on economic growth of factors such as technological change, efficiency improvements, returns to scale, and reallocation of resources.

Table 1: Contribution to growth in labour productivity, private business sector[a]
(percentage points per year)

	Annual average growth in labour productivity	Annual average growth in total factor productivity	Contribution from the change in the capital/labour ratio		Contribution from the change in the composition of labour
			Total	Info. technology	
1948-1999	2.5	1.4	0.8	0.3	0.2
1948-1973	3.3	2.1	1.0	0.1	0.2
1973-1999	1.7	0.6	0.7	0.5	0.3
1973-1995	1.5	0.5	0.7	0.4	0.3
1995-1999	2.6	1.3	1.0	0.9	0.3

a. Components may not sum to totals due to rounding.

As indicated in Table 1, labour productivity grew, on average, by 2.5 per cent per year over 1948-1999. Over this period, the growth in total factor productivity accounted for more than half of the average annual growth in labour productivity whereas the increase in the capital/labour ratio explained close to a third.

Growth in labour productivity reached 3.3 per cent per year over 1948-1973 but fell to 1.7 per cent after 1973. A significant decrease in the growth in total factor productivity largely explains the

2. Data on the capital stock include physical assets (fixed business equipment, structures, inventories, and land) and software.
3. Labour input is measured by Tornqvist-aggregation of the hours worked by all persons, classified by education, work experience, and gender with weights represented by their shares of labour compensation. The rate of growth of labour composition is computed as the difference between the rate of growth of weighted labour input and the rate of growth of total hours worked (unweighted).

post-1973 deceleration in labour productivity. A slowing in the overall pace of capital deepening also contributed to the fall in labour productivity despite a rise in the contribution from the change in the information technology capital/labour ratio.

There has been, however, a notable acceleration in labour productivity since 1995. In fact, close to three quarters of the recovery in the average annual rate of growth in labour productivity is accounted for by a rebound in the growth in total factor productivity while the rest is explained by an increase in the contribution from the change in the capital/labour ratio. Nevertheless, the rise in the contribution from the change in the IT capital/labour ratio after 1995 is noteworthy. Although our simple accounting framework can only measure the direct impact on labour productivity from the change in IT capital intensity, many studies have attributed part of the post-1995 recovery in total factor productivity to the technological progress brought about by the sharp increase in investment in information technologies since 1993 (see Table 2).[4]

Table 2: Investment in equipment and software
(average annual rate of growth)

	Total	of which: Information technology
1967-2000	6.8	14.4
1967-1992	5.2	12.9
1992-2000	12.2	19.5

As a result, the new economy is characterized by capital deepening (especially in information technologies) and a rise in total factor productivity growth. These two factors have likely resulted in an increase in the rate of growth in potential output in the United States. The next section will describe the methodology used at the Bank of Canada to measure potential GDP in the United States.

The recent evolution of U.S. potential GDP

The model used by the Staff to estimate U.S. potential GDP is a structural VAR which includes the following variables; labour productivity, the aggregate participation rate, real GDP, inflation rate, the unemployment rate and the real short-run interest rate.[5] In this model, demand shocks are assumed to have only a transitory effect on the level of real GDP. The permanent shocks on output are assumed to be supply shocks and therefore drive potential GDP. The model decomposes potential GDP into three components: permanent shocks on labour productivity, permanent

4. See, for example, Oliner, Stephen D. and Daniel E. Sichel. “The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?” *Journal of Economic Perspectives*, Vol. 14, No. 4, Fall 2000, 3-22.
5. See, Lalonde, René. “Potential GDP of the United States and its determinants: Labour productivity and participation rate.” Bank of Canada, 1998, Working Paper 98-13.

shocks on participation rate and other supply shocks which do not originate from permanent change of labour productivity and/or the participation rate.

Figure 3 shows the evolution of potential GDP as compared to real GDP. Between 1995 and the beginning of 1999, the so-called U.S. miracle period, real GDP was always very close to potential GDP. Starting in 1999Q3, Figure 4 shows a important increase of excess demand which reaches a peak of 2.3 in 2000Q2. In 1999 and 2000, the U.S. Federal Reserve seems to have reacted to the rise in excess demand by raising interest rate. Recently, the slowing of the economy is interpreted by the model as being caused by negative demand shocks. This slowing of aggregate demand is partly linked to the lagged effects of monetary policy. The recent drop in equity values can also help to explain the slowing of aggregate demand.

Figure 5 and Table 3 show that, since 1995, the growth rate of potential GDP has been significantly higher than the assumed steady-state growth rate of potential GDP (i.e. 2.8%). In 1996 and 1997, the strong growth of potential GDP was mainly explained by positive permanent shocks to the participation rate. Starting in 1998, the gap between the growth rate of potential and its steady state growth rate was the result of positive permanent shocks on labour productivity. As discussed in the preceding section, the gains in labour productivity are explained by the huge increase in investment in machinery and equipment recorded during this period and by technological advances especially in the high-tech industries.

Table 3: Recent evolution of potential GDP and output GAP

	Growth rate of real GDP	Growth rate of potential GDP	Gap between the growth rate of potential GDP and the assumed (2.8%) steady-state growth rate	Output gap (%)
1995	2.7	3.0	0.2	0.5
1996	3.6	4.2	1.4	-0.1
1997	4.4	3.9	1.1	0.4
1998	4.4	4.5	1.7	0.2
1999	4.2	3.6	0.8	0.9
2000	5.0	3.6	0.8	2.2
Average (1995-2000)	4.0	3.8	1.0	-

Relatively good inflation outcomes in the 1996-1999 period can be attributed, in part, to strong labour productivity growth, weakness in unit labour costs and an economy operating close to potential. The recent increase of the output gap can also explain the following rise in inflation and

the subsequent tightening of monetary policy in 2000. However, the impact of the recent increase of excess demand on inflation is limited by the relatively small persistence of the recent episode of excess demand[6] and by continuing productivity gains. As a matter of fact, although the growth rate of potential GDP has slowed in the last two years, it is still 3.6%, considerably above the assumed steady-state growth rate.

Conclusion

U.S. labour productivity accelerated significantly in recent years in the United States owing to a rise in the growth of total factor productivity and an increase in IT capital intensity. As a result, potential output growth also rose over the period.

6. The output gap fell somewhat during the second half of 2000 owing to the slowing of the U.S. economy. The output gap will fall further in 2001Q1, if growth in GDP remains below potential GDP growth.

Figure 1: Productivity

(annual rate of change)

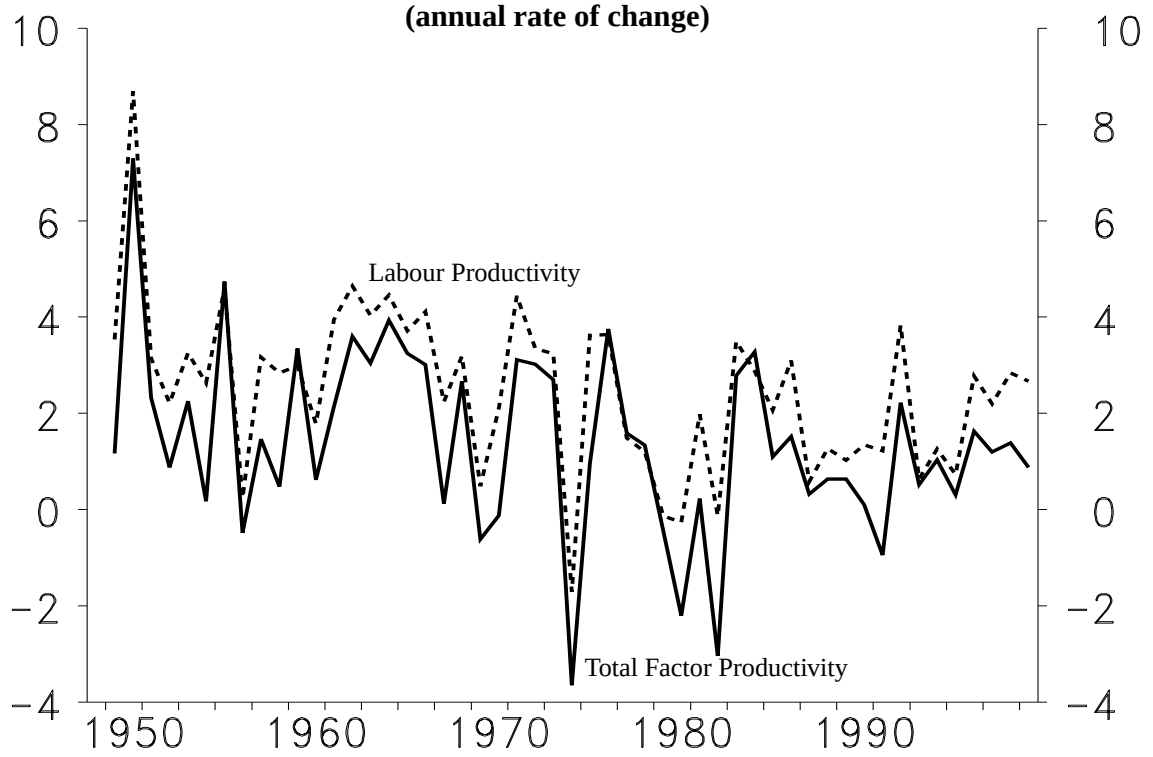

Figure 2: Capital / Labour Ratio

(level)

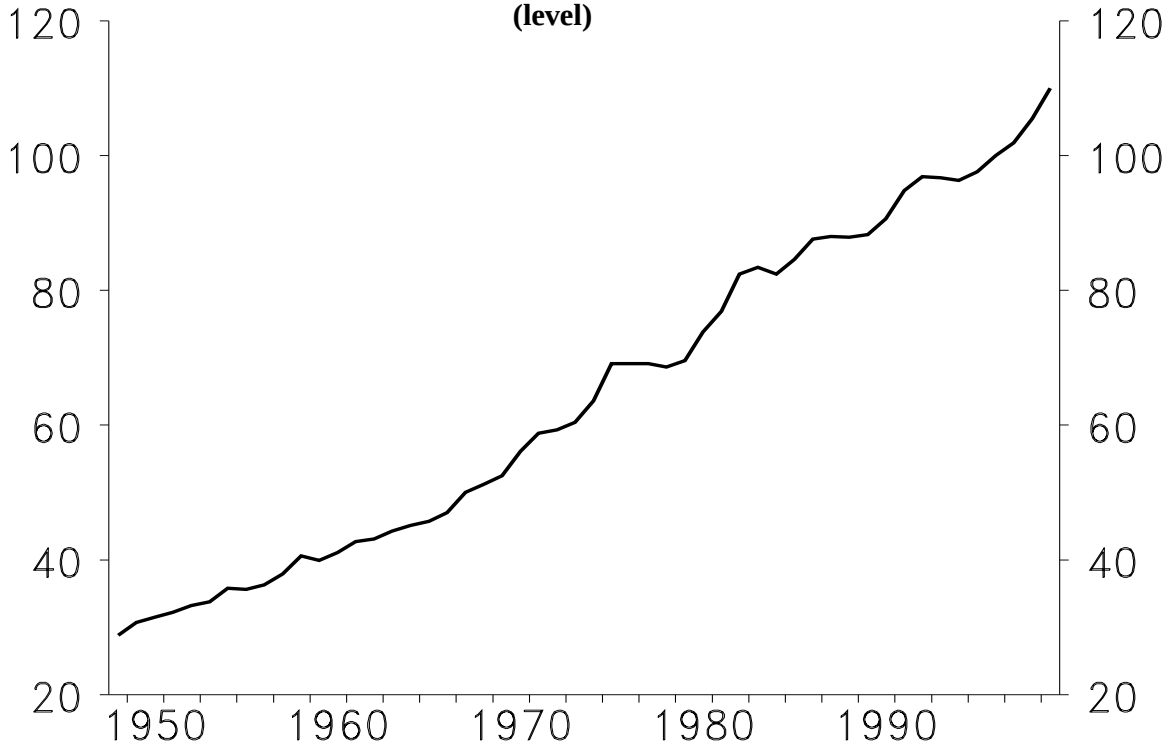

Figure 3: Level of Real GDP and Potential GDP (1969Q2 - 2000Q4)

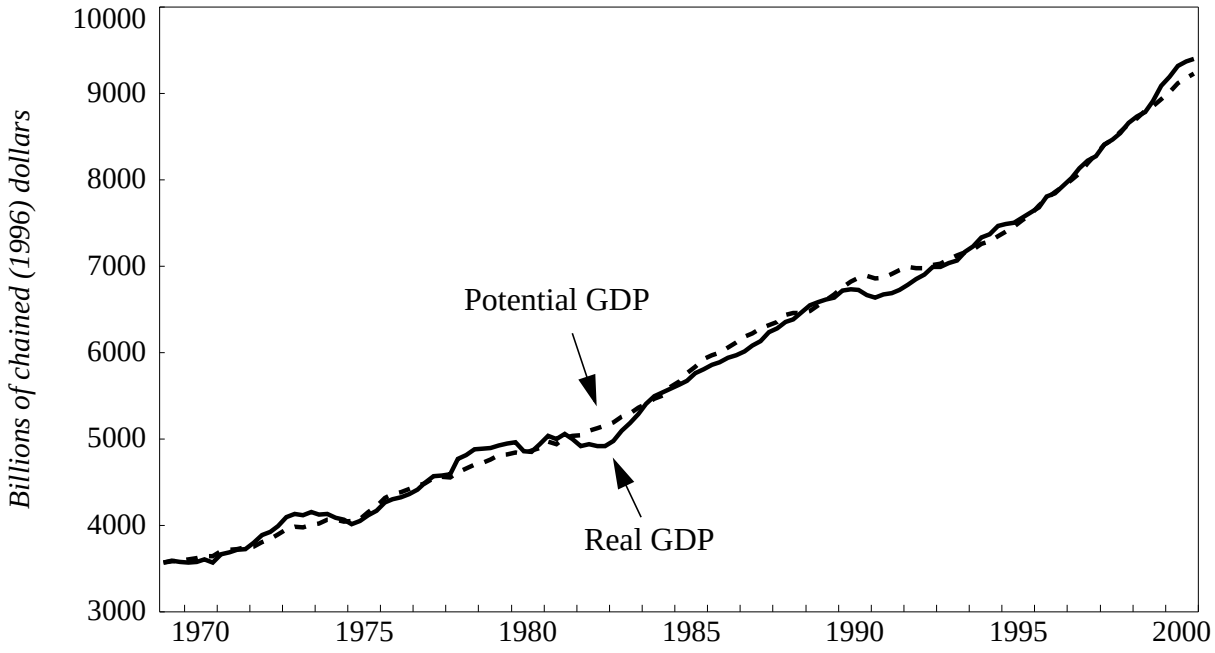

Figure 4: U.S. Output Gap (1969Q2 - 2000Q4)

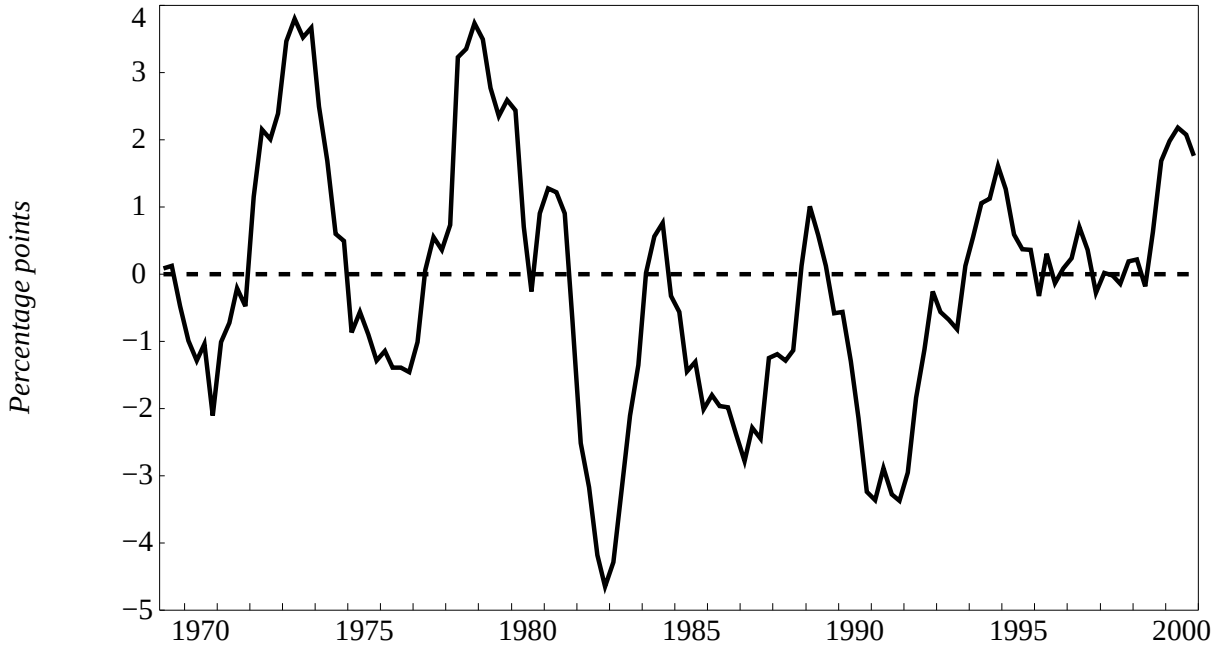

Figure 5: Growth Rate (Y/Y) of Real GDP and Potential GDP (1994Q4-2000Q4)