Economics Bulletin

Volume 39, Issue 4

Further insights into 'Baumol's disease' in Japan

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Abstract

Nishi (2018) has broken new ground in analysing whether Japan suffers from ‘Baumol's disease'. More precisely, he focuses on just one of six symptoms which Nordhaus (2008) referred to as ‘Baumol's diseases', namely on the ‘growth disease'. Nishi finds that Japan is suffering from Baumol's growth disease, although its impact is not very strong. This note aims at adding further insights into Baumol's disease in Japan by applying Nordhaus's testing strategy to the other five symptoms. Of these, the ‘cost and price disease' is most salient in Japanese data.

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Citation: Jochen Hartwig, (2019) "Further insights into 'Baumol's disease' in Japan", *Economics Bulletin*, Volume 39, Issue 4, pages 2308-2316
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Submitted: June 23, 2019.   **Published:** October 13, 2019.

1. Introduction

Structural change in Japan has not received as much attention as it deserves. Only a small number of studies have investigated the extent of shifts of output and employment between Japanese industries as well as the macroeconomic consequences of these shifts; and the empirical approach in these studies has been mostly descriptive.[1] So Nishi's (2019) recent attempt to confront one of the best-known models of structural change – Baumol's (1967) model of 'unbalanced growth' – with Japanese data is a great progress.

Baumol assumes that productivity growth is higher in the 'progressive' (secondary) than in the 'nonprogressive' – or 'stagnant' – (tertiary) sector of the economy, but wages grow more or less the same in both sectors. Therefore, unit costs and also prices rise much faster in the tertiary sector than in the secondary. Demand for certain services, like health care and education for instance, is hardly price-elastic, hence consumers are willing to pay the higher prices. Therefore, even if the two sectors keep their proportion in terms of real production, an ever-higher share of total expenditures will be channelled into the stagnant sector. This phenomenon is known as the 'cost disease'. Also, since aggregate productivity growth is a weighted average of the sectoral productivity growth rates with the weights provided by the nominal value added shares, the aggregate productivity growth rate will decline over time, according to Baumol, as the industries with low productivity growth receive an ever-increasing weight. Nordhaus (2008) called this the 'growth disease'.

Nishi focuses on the growth disease. He finds that it "silently undermines Japanese economic growth" (Nishi, 2019, p. 592). Its magnitude, however, he finds to be minuscule. This is in stark contrast to Nordhaus (2008) and Hartwig (2011), who find the economies of the US and the EU to be strongly affected by the growth disease as well as further by-products of structural change.

In this note, I apply the elegant panel-econometric testing framework for structural change that Nordhaus (2008) has developed – the same testing framework that I already adopted in Hartwig (2011) – to Japanese industry data. Leaving aside the growth disease that Nishi (2019) has thoroughly investigated, I concentrate on the five other 'diseases' identified by Nordhaus in order to contribute to a better understanding of the complex process of structural change in Japan.

What are the five remaining 'diseases'? Two of them are assumptions underlying Baumol's model; the other three are consequences from the model's assumptions, some of which are undesirable from an economic policy perspective.

1. *The cost and price disease*. The model implies that costs grow faster in stagnant industries. If we think of the 'cost explosion' in health care in most developed countries, for instance, we recognize why such a development would be politically undesirable.[2]
2. *The 'constant real share' assumption*. Baumol assumes that the relation of real output of the two sectors remains constant. This assumption has been rephrased as the 'real share maintenance' hypothesis (cf. ten Raa and Schettkat, 2001) – although conceptually, the notion of 'real' output shares does not make much sense.
3. *Unbalanced nominal growth*. Because of bullet points (1) and (2), the share of progressive industries' value added in nominal GDP should drop.
4. *Declining employment shares of progressive industries*. If the two sectors keep their 'real output shares' under conditions of unbalanced productivity growth, then labour must be re-allocated from the progressive to the stagnant industries.

[1] See Gowdy (1991), Prasad (1996), Tanuwidjaja and Thangavelu (2007), and Waldenberger (2007). Other studies such as Aghveli et al. (1998), Saxonhouse (1998) or Kimura and Schulz (2004) employ a broader definition of structural change, which includes demographic change, alterations in the society's value system under the influence of globalization or even monetary and fiscal policy.

[2] Hartwig (2008) has used Baumol's model to investigate the 'cost explosion' in health care.

5. *The assumption of uniform wage growth.* Baumol assumes uniform wage growth across industries.

Nordhaus (2008) shows that for a Cobb-Douglas economy with cost minimization and markup pricing, and an 'almost ideal' demand side in the sense of Deaton and Muellbauer (1980), hypotheses (1) to (5) can be interpreted econometrically as reduced-form equations which – under certain assumptions Nordhaus sets forth[3] – can be written as:

$$\hat{x}_{it} = \gamma_{0i} + \gamma_1 \hat{a}_{it} + \gamma_2 D_t + \varepsilon^p_{it} \qquad (1)$$

where $\hat{a}_{it}$ is the growth rate of productivity in industry *i* at time period *t* and $\hat{x}_{it}$ is a placeholder for different variables; it may stand for either real or nominal output growth, or price, wage or employment growth. D_t is a panel of fixed time effects, γ_{0i} are fixed industry effects,[4] ε^p_{it} is a random disturbance, and γ_1 and γ_2 are coefficients. Equation (1) can be estimated with the least squares dummy variables (LSDV) estimator.

Nordhaus finds favourable evidence for all of the model's implications except the 'constant real share' assumption in US GDP-by-industry data (published by the Department of Commerce's Bureau of Economic Analysis). The aim of this paper is to investigate whether the same holds true for Japan. I will test Baumol's model using data from the EU KLEMS database set up by the Groningen Growth and Development Centre (www.euklems.net).[5] The next section will dig deeper into data and modelling issues. Section 3 will present and discuss the results, and section 4 concludes.

2. Data and modelling

To eliminate the impact of the business cycle on productivity, Nordhaus (2008) calculates average growth rates over long periods with business cycle watersheds as break-point years. In my dataset covering the period 1973-2005, convenient watersheds for Japan are the years 1979, 1988, and 1996 as these are peak years in the growth cycle.[6] For the pooled estimations, I will therefore use average growth rates (geometrical means) of the variables over the sub-periods 1973-79, 1979-88, 1988-1996, and 1996-2005.[7] I will also do cross-section estimations with average growth rates over the whole sample period.

In the cross-section dimension, Nordhaus has data for 67 detailed industries and 14 broad industry groups. He claims that only 28 of the detailed industries (mainly from the industry group 'manufacturing') have relatively well-measured output. He estimates each of his equations separately with data for the 67 detailed industries, the 28 well-measured industries, and the 14 industry groups.[8] The EU KLEMS dataset for Japan distinguishes 46 detailed industries and 15 broad industry groups. Nordhaus's 28 well-measured industries can also be

[3] For the sake of brevity, I will not address issues that Nordhaus has already resolved. These include the derivation of his analytical framework and econometric issues in the specification. Also, Nordhaus provides a thorough overview of the literature on 'Baumol's disease', so this can also be dispensed with here.

[4] Random effects were rejected by the Hausman test for correlated random effects.

[5] I use the March 2008 release of the EU KLEMS database in order to render the results for Japan comparable to those for the US and EU economies reported in Hartwig (2011). Tanuwidjaja and Thangavelu (2007) use a previous version of this dataset. EU KLEMS data has the advantage over, for instance, the OECD's STAN database of covering a longer period of time. Despite its name, this dataset not only contains data for European Union (EU) countries, but also for a number of countries from outside the EU (such as Japan). Note, however, that there are no data on Japan in the newest (July 2018) release of the EU KLEMS database.

[6] Four Juglar cycles can be identified based on decreasing and increasing growth rates (dlogs) of total real gross value added. Real gross value added growth peaked at 7.8% in 1979, again at 7.8% in 1988 and finally at 3.8% in 1996.

[7] Note that (monthly) data from Japan's Cabinet Office (https://www.esri.cao.go.jp/en/stat/di/140530rdates.html) offer a somewhat different picture of the peaks of the business cycle than (annual) EU KLEMS data.

[8] Note that this implies that for the cross-section estimation over the whole sample period with data for the broad industry groups, Nordhaus has only 14 observations. While many would agree that it is not sensible to do regression analysis with so few observations, I will replicate these estimations here also.

identified in EU KLEMS data, so that all three cross-sectional sub-samples can be emulated. The appendix gives an overview of the industries and broad industry groups.

The testing strategy of Baumol's model that Nordhaus proposes draws on the fact that each of the hypotheses (1) to (5) can be rephrased in terms of a prediction about the correlation between industrial productivity growth and the growth rate of another variable. Whether the hypothesised correlations are present in the data can be tested using equation (1).

Hypothesis (1) suggests that industries with relatively low productivity growth will show relatively strong price growth. To lend empirical support to the cost and price disease hypothesis, we would thus need to find a statistically significant negative correlation between productivity growth and price growth across industries. Or in terms of equation (1), if we regress industrial price growth rates on industrial productivity growth rates (and fixed effects) we would need to find a significantly negative coefficient γ_1. Box 1 summarises the predictions about the sign of γ_1 that each of hypotheses (1) to (5) makes.[9]

Box 1: Implied coefficient signs

1. *The cost and price disease hypothesis*
   $\hat{x}_{it}$ = growth rate of price level of industry *i*. H_0: $\gamma_1 < 0$
2. *The 'constant real share' hypothesis*
   $\hat{x}_{it}$ = growth rate of real output of industry *i*. H_0: $\gamma_1 = 0$
3. *The unbalanced nominal growth hypothesis*
   $\hat{x}_{it}$ = growth rate of nominal output of industry *i*. H_0: $\gamma_1 < 0$
4. *The hypothesis of declining employment shares of productive industries*
   $\hat{x}_{it}$ = growth rate of hours worked in industry *i*. H_0: $\gamma_1 < 0$
5. *The uniform wage growth hypothesis*
   $\hat{x}_{it}$ = growth rate of wages in industry *i*. H_0: $\gamma_1 = 0$

These five hypotheses will be tested in the next section with both labour productivity growth and multi-factor productivity (MFP) growth as right-hand side variable ($\hat{a}_{it}$).

3. Results

Table 1 reports results for the tests of hypotheses (1) to (5). For each of the five dependent variables there are twelve estimated coefficients, six of which stem from regressions of the dependent variable on labour productivity growth and on multi-factor productivity growth, respectively. Note that the number of observations for the MFP regressions is smaller because MFP data are not available for every industry (group). Nordhaus (2008) and Hartwig (2011), although they are aware that the equations are not independent, calculate two averaged coefficient values over all specifications. One of them weights each coefficient with the number of observations, the other weights each equation equally. I follow them in reporting these two summary statistics at the bottom of the table.

[9] Nishi (2019) follows a different approach in classifying Japanese industries a priori as 'progressive' or 'non-progressive' based on their labor productivity growth rate compared with the aggregate labor productivity growth rate.

Table 1: Impact of productivity growth on five variables. Country: Japan. Period: 1973-2005

	$\hat{p}$		$\widehat{rgva}$		$\widehat{ngva}$		$\widehat{hemp}$		$\hat{w}$	
	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.
$\widehat{lp}$										
All 46 industries										
cross section	−0.852*** (0.040)	46	0.990*** (0.080)	46	0.084 (0.088)	46	−0.005 (0.078)	46	0.052 (0.037)	44
4 sub-periods	−0.637*** (0.061)	182	0.883*** (0.044)	182	0.199*** (0.070)	182	−0.096** (0.038)	182	0.087 (0.088)	174
28 well-measured industries										
cross section	−0.836*** (0.048)	28	1.098*** (0.067)	28	0.203** (0.089)	28	0.102 (0.064)	28	0.090** (0.038)	26
4 sub-periods	−0.728*** (0.064)	111	0.906*** (0.057)	111	0.127 (0.081)	111	−0.069 (0.048)	111	−0.035 (0.058)	103
15 industry groups										
cross section	−0.625*** (0.143)	15	0.484 (0.303)	15	−0.147 (0.371)	15	−0.507 (0.298)	15	0.023 (0.157)	15
4 sub-periods	−0.441** (0.168)	60	0.928*** (0.091)	60	0.503*** (0.179)	60	−0.058 (0.089)	60	0.364* (0.197)	60

Table 1 – cont'd

	$\hat{p}$		$\widehat{rgva}$		$\widehat{ngva}$		$\widehat{hemp}$		$\hat{w}$	
	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.	Coefficient	No. of obs.
$\widehat{mfp}$										
All 21 industries										
cross section	−0.774*** (0.098)	21	0.683*** (0.170)	21	−0.098 (0.144)	21	−0.276* (0.138)	21	0.149 (0.098)	21
4 sub-periods	−0.552*** (0.118)	84	0.832*** (0.070)	84	0.243** (0.116)	84	−0.000 (0.059)	84	0.259 (0.207)	84
11 well-measured industries										
cross section	−0.849*** (0.133)	11	0.840** (0.263)	11	−0.036 (0.218)	11	−0.234 (0.192)	11	0.125 (0.072)	11
4 sub-periods	−0.669*** (0.095)	44	0.875*** (0.072)	44	0.147 (0.107)	44	−0.023 (0.060)	44	0.026 (0.067)	44
13 industry groups										
cross section	−0.588*** (0.184)	13	0.326 (0.292)	13	−0.273 (0.345)	13	−0.652** (0.258)	13	−0.057 (0.141)	13
4 sub-periods	−0.331** (0.129)	52	0.685*** (0.076)	52	0.353** (0.141)	52	0.028 (0.076)	52	0.302** (0.135)	52
Summary statistics										
weighted	−0.632		0.858		0.191		−0.075		0.125	
unweighted	−0.657		0.794		0.109		−0.149		0.115	

lp = labour productivity (gross value added per hour worked, indices, 1995=100), mfp = multi-factor productivity (indices, 1995=100), p = price level (deflator of gross value added), rgva = real gross value added (indices, 1995 = 100), ngva = nominal gross value added (in millions of Japanese Yens), hemp = total hours worked by persons engaged, w = labour compensation per hour (in millions of Japanese Yens). Standard errors are in parenthesis. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Estimates for constant terms not shown.

Source: EU KLEMS data (www.euklems.net).

Table 1 offers mixed evidence on whether Japan is affected by 'Baumol's diseases'. Looking at relative price growth, the evidence is very favourable to Baumol's model. Industries with high labour productivity or multi-factor productivity growth show low price growth, which means that their relative prices decline (just as Baumol's model predicts). All estimated coefficients are statistically significant at the 5% level (or better). Compared to the EU, the coefficients for Japan are higher in absolute terms. Nordhaus (2008, p. 10) notes that a coefficient close to -1 means that "consumers capture virtually all the gains from technological change". Apparently, Japanese consumers benefit more from technological progress than their European counterparts do.

The second hypothesis posits the constancy of the 'real share' of the stagnant sector, which means, of course, that the 'real share' of the progressive sector also remains constant. Under these circumstances, both sectors must grow at equal pace. Productivity growth, therefore, should have no impact on real output growth.

If we want to test the 'constant real share' hypothesis we first need to decide how to measure real output. There are in principle two possibilities, namely gross output and value added. Nordhaus argues in favour of using value added data because value added allows better than gross output for tracking the industrial source of technological advances that lead to productivity growth. I will follow his lead.[10]

Table 1 shows that the 'constant real share' hypothesis is predominantly rejected. When sectoral real value added growth is regressed on sectoral productivity growth (and fixed effects), only two out of twelve coefficients are insignificant. The other ten are significantly positive, indicating that industries with relatively high productivity growth grow faster in terms of real value added than stagnant industries. If the progressive industries grow faster than the stagnant industries, their 'real share' will rise.

With respect to hypothesis (2), the results for Japan and the EU are similar. The EU coefficients are also mostly positive and statistically significant. However, the Japanese coefficients are higher in absolute terms than their EU counterparts (cf. Table 1).

The results for nominal value added growth given in the sixth column of Table 1 are hard to interpret. The signs on the coefficients depend on whether or not the positive impact of productivity growth on relative real value added growth outweighs its negative impact on relative price growth in the respective industry sample. Four coefficients are negative, eight are positive; and only positive coefficients (five of them) are statistically significant. Nordhaus, for his part, finds a *negative* association between productivity growth and nominal value added growth which is, however, only marginally statistically significant. Hartwig's (2011) results for the EU are mixed. For the time being, the evidence on hypothesis (3) remains inconclusive.

Hypothesis (4) states that industries with high productivity growth have low labour input growth, which leads to a decline of their share in total employment over time. For this hypothesis, the empirical evidence from EU KLEMS data for Japan is predominantly favourable. Ten out of twelve coefficients are negative, three of which are significant at the ten percent level or better. This result is similar to my earlier findings for the EU, except that the averaged coefficients for Japan are much lower in absolute terms than those found for the EU.

The penultimate column of Table 1 gives the estimated coefficients from regressions of the growth rates of labour compensation per hour on productivity growth,[11] which should be insignificant according to hypothesis (5). While most of my estimated coefficients for Japan

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[10] The distinction between value added and gross output is relevant for Baumol's 'growth disease' since Oulton (2001) was able to show that the shift of resources to the service sector may raise rather than lower aggregate productivity growth if the service industries produce intermediate rather than final products (see also ten Raa and Schettkat 2001). Hartwig and Krämer (2019), analyzing EU KLEMS data for G7 countries, show that this effect has not been strong enough to have 'cured' Baumol's 'growth disease', however.

[11] No labour compensation data are available for the industries 'Mining and quarrying of energy producing materials' and 'Mining and quarrying except energy producing materials'; therefore we lose two observations.

are insignificant and small, two estimates are significantly positive and lie above 0.3. Again, this result is similar to that for the EU. Hartwig (2011) also found mostly insignificant coefficients, but also two significantly positive ones around 0.3. The bottom line is that the test does not yield conclusive evidence in favour or against hypothesis (5).

4. Conclusion

Nishi (2019) has broken new ground in analysing whether Japan suffers from Baumol's growth disease. However, there are other symptoms of what Nordhaus (2008) has dubbed 'Baumol's diseases'. This note answers the question whether Japan is affected by those symptoms also. I draw on Nordhaus's methodology and on EU KLEMS data (collected and published by the Groningen Growth and Development Centre), which I organise in a similar way as Nordhaus organises his data. My results suggest that Japan, just like the US and the EU, suffers from the 'cost disease'. However, there are certain differences between my findings for Japan and those for the US and the EU by Nordhaus (2008) and Hartwig (2011). The responsiveness of relative prices to advances in productivity seems to be more modest in Japan than in the US, but stronger than in the EU. The drop in hours worked in the progressive relative to the stagnant industries is less pronounced in Japan than in the US and the EU. Maybe – unlike in the US – wage growth in Japanese (as well as in European) industry groups depends on productivity growth, yet this remains unclear since somewhat puzzling differences between coefficient estimates from pooled and from cross-section estimations have been found. These deserve further attention.

Altogether, the evidence produced by Nishi (2019) and this study suggest that while the impact of Baumol's 'growth disease' on the Japanese economy is weak, the impact of Baumol's 'cost disease' is more clearly traceable.

Appendix: Industry definition

Industries correspond to the NACE codes (Version 4 Rev. 1 1993).

<u>All 46 detailed industries</u>

(An asterisk denotes that the industry roughly corresponds to one of Nordhaus's 'well-measured industries')

Agriculture*
Forestry
Fishing
Mining and quarrying of energy producing materials*
Mining and quarrying except energy producing materials*
Manufacturing of food products; beverages and tobacco*
Manufacture of textiles, wearing apparel; dressing and dying of fur*
Manufacture of leather and leather products*
Manufacture of wood and wood products*
Manufacture of pulp, paper and paper products*
Publishing, printing and reproduction of recorded media*
Manufacture of coke, refined petroleum and nuclear fuel
Manufacture of chemicals and chemical products*
Manufacture of rubber and plastic products*
Manufacture of other non-metallic mineral products*
Manufacture of basic metals*

Manufacture of fabricated metal products*
Manufacture of machinery and equipment*
Manufacture of office, accounting and computing machinery*
Manufacture of electrical machinery and apparatus, n.e.c*
Manufacture of radio, television and communication equipment and apparatus*
Manufacture of medical, precision and optical instruments, watches and clocks
Manufacture of motor vehicles, trailers and semi-trailers*
Manufacture of other transport equipment*
Manufacture of furniture; manufacturing n.e.c.; recycling*
Electricity, gas and water supply*
Construction
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
Wholesale trade*
Retail trade*
Hotels and restaurants
Land transport; transport via pipelines*
Water transport*
Air transport*
Supporting and auxiliary transport activities; activities of travel agencies
Post and telecommunication*
Financial intermediation and insurance
Real estate activities
Renting of machinery and equipment
Computer and related activities
Research and development
Other business activities
Public administration and defence; compulsory social security
Education
Health and social work
Sewage and refuse disposal; activities of membership organizations; recreational, cultural and sporting activities; other service activities

15 industry groups

Agriculture, hunting, and forestry
Fishing
Mining and quarrying
Manufacturing
Electricity, gas and water supply
Construction
Wholesale and retail trade; repair of motor vehicles and motorcycles and personal and household goods
Hotels and restaurants
Transport, storage and communication
Financial intermediation and insurance
Real estate, renting, business activities and R&D
Public administration and defence; compulsory social security
Education
Health and social work
Other community, social and personal service activities

Acknowledgement

I would like to thank a reviewer for thoughtful comments that greatly helped to improve the paper. The usual disclaimer applies.

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