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# TESTING THE BAUMOL–NORDHAUS MODEL WITH EU KLEMS DATA

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Baumol's (1967) seminal model of structural change predicts that large service industries financed mainly through taxes and social contributions—like health care and education, for instance—will acquire ever-larger shares of total expenditures and that, concomitantly, overall productivity growth will decline. Applying a new testing strategy for Baumol's model, Nordhaus (2008) finds strong evidence in favor of the "cost and growth diseases" in U.S. GDP-by-industry data (published by the Department of Commerce's Bureau of Economic Analysis). The aim of the present paper is twofold. The first is to check whether Nordhaus's results can be reproduced using U.S. industry data from the EU KLEMS database. Second, Nordhaus's testing methodology is applied to European Union data from the same database. The results suggest that—although there are differences vis-à-vis the U.S.—the EU also shows symptoms of "Baumol's diseases."

## 1. Introduction

William J. Baumol's (1967) article "Macroeconomics of Unbalanced Growth" is widely regarded as a major contribution to the literature on structural change. In a nutshell, the model's story goes like this. Productivity growth is higher in the "progressive" (secondary) than in the "non-progressive"—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 channeled 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 as the industries with low productivity growth receive an ever-increasing weight. Nordhaus (2008) calls this the "growth disease."

Nordhaus discerns six hypotheses at the base of Baumol's model that can be tested empirically. These are:

(1) *The cost and price disease hypothesis*. The model implies that costs grow faster in stagnant industries; and Baumol assumes that prices are set as a mark-up over costs. If we think of the "cost explosion" in health care in

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most developed countries, for instance, we recognize why such a development would be politically undesirable.[1]

(2) *The "constant real share" hypothesis*. 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 is problematic.

(3) *The unbalanced nominal growth hypothesis*. As a consequence of bullet points (1) and (2), the share of progressive industries' value added in nominal GDP should drop.

(4) *The hypothesis of declining employment shares of progressive industries*. If the two sectors keep their "real output shares" under conditions of unbalanced productivity growth, then labor must be reallocated from the progressive to the stagnant industries.

(5) *The uniform wage growth hypothesis.* Baumol assumes uniform wage growth across industries.

(6) *The growth disease hypothesis.* Baumol's model predicts that unbalanced productivity growth will lead to a decrease in the growth rate of overall GDP over time.

Introducing an elegant panel-econometric testing framework for Baumol's model, Nordhaus (2008) finds evidence in favor of all hypotheses except hypothesis (2) in U.S. GDP-by-industry data (published by the Department of Commerce's Bureau of Economic Analysis, BEA). Section 3 below will apply Nordhaus's testing strategy—which is explained in Section 2—to U.S. industry data from the EU KLEMS database (March 2008 release, see www.euklems.net). This replication exercise aims above all at checking the robustness of Nordhaus's findings. While *a priori* a large degree of correspondence between the results can be expected because the consortium of institutes that compiled the EU KLEMS database inevitably had to draw heavily on data from the National Statistical Institutes (NSIs),[2] differences might stem from the fact that the EU KLEMS consortium also had to process NSI data in order to bridge existing gaps and to achieve international comparability. O'Mahony and Timmer (2009, p. F395) note that "by confronting various data sources within and across countries, the EU KLEMS database is useful in indicating priority areas for further improvement in basic series including volume measures of services output, capital formation matrices and more generally consistency between output, labor and capital inputs at the industry level." Section 3 below intends to contribute to such kinds of consistency checks.

The second aim of the paper is to apply Nordhaus's testing methodology to European data. Rivers of ink have been dedicated to document the Atlantic Ocean divide in GDP and productivity growth before the recent economic crisis; and although skeptics have pointed to measurement differences as a contributing factor to this divide (see Hartwig, 2007, for instance), factors like the more rigid market institutions, lower competitive forces, and a lower degree of ICT capital

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

[2]See O'Mahony and Timmer's (2009) appendix A for a list of the institutes which participated in compiling the EU KLEMS database.

utilization in Europe as compared to the U.S. have usually been blamed for Europe's lagging behind. The question is then whether these differences between Europe and the U.S. also lead to a different susceptibility to "Baumol's diseases."

Section 4 tests the "Baumol–Nordhaus model"—i.e. the combination of Baumol's theoretical model and Nordhaus's empirical model—with EU KLEMS data for an aggregate of EU countries. The results suggest that—although there are certain differences vis-à-vis the U.S.—the EU is also affected by the "cost disease." However, there might be a conceptual problem lurking here. There is a wide range of productivity growth rates across European countries, and using only the aggregate sweeps much (and potentially interesting) heterogeneity under the rug (see, for instance, Inklaar *et al.*, 2008). Section 4.3 therefore takes a closer look at the country with the lowest aggregate productivity growth over the period 1970–2005 (Italy) as well as at the country with the highest aggregate productivity growth (Finland). Despite their divergent productivity performance, the two countries do not perform very differently in the Baumol–Nordhaus tests.

Testing the sixth—and probably most worrisome—hypothesis listed above, the "growth disease" hypothesis, requires a different approach than testing the other five. Nordhaus proposes a non-parametric test that will be explained below in Section 5. The test affirms that the European Union—just like the U.S. according to Nordhaus—shows symptoms of the "growth disease." Section 6 concludes.

## 2. Modeling

Nordhaus shows that for a Cobb–Douglas economy with cost minimization and mark-up 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 that Nordhaus sets forth[3]—can be written as:

$$\hat{x}_{it} = \gamma_{0i} + \gamma_1 \hat{a}_{it} + \gamma_2 D_t + \varepsilon_{it}^p \tag{1}$$

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, $\gamma_{0i}$ are fixed industry effects, $\varepsilon_{it}^p$ is a random disturbance, and $\gamma_1$ and $\gamma_2$ are coefficients. Equation (1) can be estimated with pooled OLS.

This testing strategy of Baumol's model draws on the fact that each of the hypotheses (1) to (5) listed in the introduction can be rephrased in terms of a prediction about the correlation between industrial productivity growth and the growth rate of another variable. Whether the hypothesized correlations are present in the data can be tested using equation (1). Hypothesis (1), for instance, 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,"

[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.

TABLE 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*. $H_0$: $\gamma_1 = 0$ |

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 $\gamma_1$. Table 1 summarizes the predictions about the sign of $\gamma_1$ that each of hypotheses (1) to (5) makes.

## 3. Trying to Replicate Nordhaus's Results with EU KLEMS Data for the U.S.

Table 2 compares Nordhaus's coefficient estimates with those obtained from estimations using U.S. data from the EU KLEMS database and—in the last line of the table—data from the OECD's Structural Analysis (STAN) database (2008 edition).[4] There are columns for each of the five dependent variables and lines for the two explanatory variables "labor productivity growth" and "multi-factor productivity (MFP) growth."[5]

Nordhaus's BEA data cover a much longer time period than the two other databases, namely the period 1948–2001. He reports coefficient estimates from cross-sectional regressions using average growth rates over the whole period 1948–2001 and also over the period 1977–2000 because the data for the latter sample "are constructed on a consistent basis by the BEA and are probably of better quality than the earlier years" (Nordhaus, 2008, p. 8). As the period 1977–2000 is also covered (more or less) by the EU KLEMS and STAN databases,[6] it lends itself to a comparison.

The Bureau of Economic Analysis implemented the new North American Industry Classification System (NAICS) in 2004; before that the Standard Industrial Classification System (SIC) was used. The BEA still publishes data for both systems on its website. Nordhaus uses SIC data because they stretch further back in time. The STAN database, on the other hand, reports NAICS data. As

[4]STAN data have been downloaded from www.stats.oecd.org.

[5]There are no MFP data in the STAN database.

[6]The EU KLEMS database (March 2008 edition) covers the period 1970–2005, and the STAN database (2008 edition) covers the period 1980–2007. For some industries, there are data back to 1970 in the STAN database also.

TABLE 2

Impact of Productivity Growth on Five Variables According to Different Datasets and Estimation Periods; Country: USA

| Dataset and time period | | $\hat{p}$ | | $\widehat{rgva}$ | | $\widehat{ngva}$ | | $\widehat{hemp}$ | | $\hat{w}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Coefficient | No. of obs. | Coefficient | No. of obs. | Coefficient | No. of obs. | Coefficient | No. of obs. | Coefficient | No. of obs. |
| Nordhaus (2008) | $\widehat{lp}$ | –1.021 | 62 | 0.630 | 62 | – | – | –0.370 | 62 | –0.056 | 62 |
| SIC data | | (0.052) | | (0.101) | | | | (0.101) | | (0.039) | |
| 1977–2000 | $\widehat{mfp}$ | –1.008 | 56 | 0.662 | 56 | – | – | –0.253 | 56 | –0.088 | 56 |
| | | (0.041) | | (0.093) | | | | (0.103) | | (0.037) | |
| EU KLEMS | $\widehat{lp}$ | –0.683 | 54 | 0.962 | 54 | –0.002 | 54 | –0.046 | 54 | 0.022 | 54 |
| SIC data | | (0.025) | | (0.052) | | (0.057) | | (0.051) | | (0.033) | |
| 1977–2000 | $\widehat{mfp}$ | –0.809 | 29 | 0.868 | 29 | 0.017 | 29 | –0.228 | 29 | 0.206 | 29 |
| | | (0.084) | | (0.127) | | (0.172) | | (0.135) | | (0.088) | |
| EU KLEMS | $\widehat{lp}$ | –0.718 | 54 | 0.951 | 54 | –0.032 | 54 | –0.049 | 54 | 0.003 | 54 |
| SIC data | | (0.023) | | (0.047) | | (0.046) | | (0.047) | | (0.024) | |
| 1970–2005 | $\widehat{mfp}$ | –0.919 | 29 | 0.804 | 29 | –0.152 | 29 | –0.312 | 29 | 0.145 | 29 |
| | | (0.077) | | (0.127) | | (0.134) | | (0.129) | | (0.074) | |
| EU KLEMS | $\widehat{lp}$ | –0.600 | 55 | 0.941 | 55 | –0.007 | 55 | –0.041 | 55 | 0.029 | 55 |
| NAICS data | | (0.021) | | (0.034) | | (0.035) | | (0.033) | | (0.016) | |
| 1977–2005 | $\widehat{mfp}$ | –0.941 | 29 | 0.769 | 29 | –0.227 | 29 | –0.257 | 29 | 0.005 | 29 |
| | | (0.070) | | (0.129) | | (0.142) | | (0.125) | | (0.058) | |
| STAN | $\widehat{lp}$ | –0.800 | 27 | 0.761 | 27 | –0.113 | 27 | –0.239 | 27 | – | – |
| NAICS data | | (0.055) | | (0.112) | | (0.119) | | (0.112) | | | |
| 1980–2007 | | | | | | | | | | | |

*Notes*: lp = labor productivity (gross value added per hour worked, indices), mfp = multi-factor productivity (indices), p = price level (deflator of gross value added), rgva = real gross value added (indices), ngva = nominal gross value added (million US$), hemp = total hours worked by persons engaged, w = labor compensation per hour (million US$). SIC = Standard Industrial Classification System, NAICS = North American Industry Classification System.

Standard errors are in parentheses.

Nordhaus notes, both datasets are incompatible because major changes in industrial classification occurred in the transition from SIC to NAICS. Fortunately, the EU KLEMS database allows us to bridge these differences because it contains both SIC and NAICS data for the U.S.[7] Normally, the EU KLEMS 1977–2000 SIC estimates should come closest to Nordhaus's values. The EU KLEMS 1977–2005 NAICS estimates on the other hand should show a similar pattern as the STAN estimates. The table also reports estimates for the whole period for which EU KLEMS SIC data are available, i.e. the period 1970–2005.

Table 2 shows both similarities and differences between data sources. The most striking similarity is that the effect of relative productivity growth on relative price growth is significantly negative across all databases and that the effect on relative real gross value added growth is always significantly positive. For the regressions of nominal value added growth on productivity growth Nordhaus does not report detailed results. He notes, however, that in theory the coefficients should be equal to the sum of the coefficients on price and real value added growth and that this was in fact the case in his estimations. He finds a negative yet only marginally significant association between productivity growth and nominal value added growth. In my estimations with EU KLEMS and STAN data, the coefficients are also mostly negative, but thoroughly insignificant. Contrary to Nordhaus's finding, the coefficient values are not very close to the sum of the coefficients from the price and real value added growth estimations.

The effects of productivity growth on hours worked and labor compensation growth are also broadly consistent across databases, yet some notable differences emerge.[8] Like Nordhaus, I find consistently negative coefficients in the regressions of hours worked growth on productivity growth and mostly small and insignificant coefficients in the regressions of labor compensation growth on productivity growth. (Both findings are in line with the implications of Baumol's model.) However, unlike Nordhaus, I find the effects of productivity growth on hours worked growth not always to be *significantly* negative.[9] Perhaps the most striking difference is that the effect of multi-factor productivity growth on labor compensation growth is significantly positive in EU KLEMS SIC data but significantly negative in Nordhaus's (SIC) data. Also, the (negative) effects of productivity growth on relative price growth are notably weaker while the (positive) effects on relative real value added growth are notably stronger in EU KLEMS data as compared to Nordhaus's BEA dataset. The most obvious explanation for these differences is that the delineation and number of industries diverge between the databases.[10] Nevertheless, given that the underlying basic (SIC) data and the

[7]NAICS has one observation more than SIC (for the industry "activities related to financial intermediation," NACE 67).

[8]Note that there are no data on hours worked and labor compensation per hour for persons engaged in the STAN database. Full-time equivalents of persons engaged were used to approximate labor input.

[9]Nordhaus does find some insignificant (and even positive) coefficients, but not for the detailed set of industries over the period 1977–2000.

[10]A minor difference is that I thoroughly exclude the real estate industry (NACE 70) from the analysis because most of its output consists of imputed housing rents. Nordhaus, for his part, includes this industry. The exclusion of NACE 70 is not responsible for the divergence between Nordhaus's and my results based on EU KLEMS data, however. Inclusion of NACE 70 barely changes my coefficient estimates.

observation period are the same, a greater coherence between the results might have been expected. This may induce researchers to further scrutinize the datasets on which Table 2 builds.

## 4. Testing the Baumol–Nordhaus Model with EU KLEMS Data for Europe

### 4.1. *Data and Measurement Issues*

Following related research (for instance, Inklaar *et al.*, 2008), I will concentrate on the aggregated EU15 countries excluding Greece, Ireland, Luxembourg, Portugal, and Sweden—the country group called EU15ex in the database, which represented 92 percent of GDP in the EU15 and 83 percent of GDP in the EU-25 in 2005—because only for this group of countries are estimates of multi-factor productivity growth available in the EU KLEMS database.[11]

To allow for a comparison with Nordhaus's results for the U.S. in the best way possible, I will arrange the EU KLEMS data for Europe in a similar way that he does. As was mentioned in Section 3, Nordhaus calculates average growth rates over the whole observation period 1948–2001 as well as over the period 1977–2000. Additionally, he constructs a panel of cross-sectional and time-series data. Nordhaus stipulates two criteria for choosing the sub-periods: (1) the periods should be of approximately equal length, and (2) they should cover a whole business cycle (from peak to peak). He thus arrives at four different sample periods, namely 1948–59, 1959–73, 1973–89, and 1989–2001.

If we apply the same two criteria to the EU KLEMS data for the European Union, we can identify the years 1979, 1988, and 2000 as convenient business cycle watersheds. These years are business cycle peaks, and the resulting sub-periods 1970–79, 1979–88, and 1988–2000 are of similar length. This is not the case for the last sub-period 2000–05 of course. Unfortunately however, 2005 is the cut-off year of the March 2008 edition of the EU KLEMS database.[12]

In the cross-section dimension, Nordhaus has 67 detailed industries and 14 broad industry groups.[13] He claims that only 28 of the detailed industries (mainly from the industry group "manufacturing") have relatively well-measured output. The distinction between "measurable" and "unmeasurable" sectors—the latter including construction, finance, other services, and government—was introduced by Griliches (1994). As Berndt and Hulten (2007, p. 5) make clear in their introduction to a conference volume honoring Griliches, the measurement problems in services sectors are not specific to the U.S., but "emanate from the fact that the units of measurement of the underlying product are very difficult to define."

[11]MFP data cover the period 1980–2005. All other data cover the period 1970–2005.

[12]After the first draft of this paper had been completed, the November 2009 update of the EU KLEMS database was published on the website www.euklems.net, which also covers the years 2006/07. The period 2000–07 would clearly give a more complete picture of the last business cycle from peak to peak. However, at the time of writing this, data for the aggregate of EU15ex countries have not yet been uploaded. Also, the November 2009 update covers a smaller set of industries than the March 2008 update. Therefore, the November 2009 update of the EU KLEMS database has not been considered for this paper.

[13]A number of these 67 industries have missing data, depending on the sample period (see Nordhaus, 2008, table 1).

O'Mahony and Timmer (2009, p. F390) confirm that the reliability of the data is also lower for service industries—especially for "non-market services" such as public administration, education, health, and social services—than for manufacturing in EU KLEMS data. Increasing the industry detail and going further back in time also impairs data quality.[14]

Nordhaus estimates each of his equations separately with data for the 67 detailed industries, the 28 well-measured industries, and the 14 industry groups.[15] The EU KLEMS dataset distinguishes 47 detailed industries and 16 broad industry groups. Nordhaus's well-measured industries can also be 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.[16]

In the next section, the five hypotheses described in Table 1 will be tested with both labor productivity growth and multi-factor productivity growth as right-hand side variable ($\hat{a}_{it}$). (EViews v.6 is used for the estimations.)

## 4.2. *Results*

Table 3 reports results for the tests of hypotheses (1) to (5). For each of the five dependent variables there are 12 estimated coefficients, six of which stem from regressions of the dependent variable on labor 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, although he is aware that the equations are not independent, calculates two averaged coefficient values over all his specifications. One of them weights each coefficient with the number of observations, the other weights each equation equally. I follow Nordhaus in reporting these two summary statistics at the bottom of the table. I also report Nordhaus's U.S. estimates for comparison.

Table 3 offers mixed evidence on whether the European Union is affected by "Baumol's diseases." Looking at relative price growth, the evidence is mostly favorable to Baumol's model. Industries with above-average labor productivity growth show below-average price growth, which means that their relative prices decline (just as Baumol's model predicts). For multi-factor productivity growth, the signs are also negative, but only significant in the cross-section estimations.

The last two lines of the table show that Nordhaus's coefficient estimates for price growth are much higher on average in absolute terms than those obtained for Europe. The reason is that, unlike Nordhaus, I find much lower coefficient values (in absolute terms) in the pooled than in the cross-section estimations. The cross-section estimates for Europe, on the other hand, come close to those reported by

[14]See O'Mahony and Timmer (2009, pp. F390–5) for a detailed account of measurement issues in EU KLEMS.

[15]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.

[16]There are two differences vis-à-vis Nordhaus (2008). Firstly, I exclude NACE 70 (see footnote 10). Secondly, unlike Nordhaus, I include the industry "hotels and restaurants" (NACE 55) among the well-measured industries because there is evidence that the measurement of output in this industry has improved considerably (see Inklaar *et al.*, 2008, pp. 179–80).

TABLE 3

Impact of Productivity Growth on Five Variables; Aggregate of EU15 Countries Excluding Greece, Ireland, Luxembourg, Portugal, and Sweden (EU15ex); Period: 1970–2005

| | $\hat{p}$ | | $\widehat{rgva}$ | | $\widehat{ngva}$ | | $\widehat{hemp}$ | | $\hat{w}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | –0.737*** | 46 | 0.370** | 46 | –0.388*** | 46 | –0.605*** | 46 | 0.063 | 46 |
| | (0.080) | | (0.133) | | (0.142) | | (0.130) | | (0.065) | |
| 4 sub-periods | –0.346*** | 184 | 0.660*** | 184 | 0.321*** | 184 | –0.306*** | 184 | 0.332*** | 184 |
| | (0.102) | | (0.053) | | (0.119) | | (0.051) | | (0.069) | |
| 30 well-measured industries | | | | | | | | | | |
| Cross section | –0.823*** | 30 | 0.578*** | 30 | –0.268** | 30 | –0.397*** | 30 | –0.015 | 30 |
| | (0.087) | | (0.141) | | (0.119) | | (0.135) | | (0.063) | |
| 4 sub-periods | –0.431*** | 120 | 0.682*** | 120 | 0.252* | 120 | –0.272*** | 120 | 0.279*** | 120 |
| | (0.097) | | (0.069) | | (0.132) | | (0.065) | | (0.078) | |
| 16 industry groups | | | | | | | | | | |
| Cross section | –0.628*** | 16 | –0.037 | 16 | –0.679** | 16 | –1.007*** | 16 | 0.118 | 16 |
| | (0.139) | | (0.208) | | (0.276) | | (0.203) | | (0.117) | |
| 4 sub-periods | –0.492*** | 64 | 0.633*** | 64 | 0.140 | 64 | –0.340*** | 64 | 0.188 | 64 |
| | (0.141) | | (0.085) | | (0.164) | | (0.084) | | (0.120) | |
| $\widehat{mfp}$ | | | | | | | | | | |
| All 29 industries | | | | | | | | | | |
| Cross section | –0.986*** | 29 | 0.410** | 29 | –0.587*** | 29 | –0.539** | 29 | 0.004 | 29 |
| | (0.105) | | (0.188) | | (0.196) | | (0.232) | | (0.099) | |
| 3 sub-periods | –0.291 | 87 | 0.613*** | 87 | 0.337 | 87 | –0.373*** | 87 | 0.223 | 87 |
| | (0.256) | | (0.088) | | (0.279) | | (0.092) | | (0.164) | |
| 21 well-measured industries | | | | | | | | | | |
| Cross section | –0.921*** | 21 | 0.713*** | 21 | –0.212 | 21 | –0.174 | 21 | 0.087 | 21 |
| | (0.110) | | (0.203) | | (0.242) | | (0.266) | | (0.111) | |
| 3 sub-periods | –0.254 | 63 | 0.602*** | 63 | 0.346 | 63 | –0.323*** | 63 | 0.132 | 63 |
| | (0.185) | | (0.106) | | (0.236) | | (0.118) | | (0.144) | |
| 13 industry groups | | | | | | | | | | |
| Cross section | –0.845*** | 13 | 0.157 | 13 | –0.706 | 13 | –0.814 | 13 | 0.082 | 13 |
| | (0.146) | | (0.354) | | (0.394) | | (0.522) | | (0.118) | |
| 3 sub-periods | –0.374 | 39 | 0.463*** | 39 | 0.097 | 39 | –0.567*** | 39 | –0.030 | 39 |
| | (0.285) | | (0.134) | | (0.334) | | (0.126) | | (0.227) | |
| Summary statistics | | *Nordhaus (2008)* | | *Nordhaus (2008)* | | *Nordhaus (2008)* | | *Nordhaus (2008)* | | *Nordhaus (2008)* |
| Weighted | –0.464 | *–0.956* | 0.569 | *0.670* | 0.120 | *–0.276* | –0.381 | *–0.282* | 0.197 | *–0.001* |
| Unweighted | –0.594 | *–0.942* | 0.487 | *0.670* | –0.112 | *–0.272* | –0.476 | *–0.258* | 0.122 | *0.017* |

*Notes*: lp = labor 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 (million PPP-converted Euros), hemp = total hours worked by persons engaged, w = labor compensation per hour (million PPP-converted Euros).

Standard errors are in parentheses.

***, **, and *denote significance at the 1%, 5%, and 10% levels, respectively. Estimates for constant terms not shown.

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

Nordhaus for the U.S. As a matter of fact, a comparison of Tables 2 and 3 reveals that in EU KLEMS data the "European" coefficients are even higher in absolute terms than those for the U.S. (which are lower than those Nordhaus reports). Therefore, one cannot conclude that European consumers benefit less from technological change than their U.S. counterparts.[17]

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 favor 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. Following his lead will allow us to compare the results for the U.S. and the EU15ex aggregate.

Table 3 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. *Ceteris paribus*, this is a palliative against "Baumol's diseases" because it cushions the rise in the nominal value added share of the stagnant industries.

With respect to hypothesis (2), the findings for Europe are similar to Nordhaus's. His coefficients are always positive and generally statistically significant. In their magnitude, the EU15ex coefficients for real value added growth are a bit lower than those reported by Nordhaus and a lot lower than the U.S. coefficients calculated with EU KLEMS and STAN data (see Table 2). So there is evidence across databases that relative productivity growth has a stronger impact on industries' relative real value added growth in the U.S. than in Europe.

As was mentioned above, the results given in the sixth column of Table 3 for the regressions of nominal value added growth on productivity growth should in theory be equal to the sum of the coefficients on price and output. The European values conform much better to this claim than their U.S. counterparts reported in Table 2. If we look at the unweighted average of the coefficients for the EU15ex aggregate, for instance, we find that the identity approximately holds ($-0.594 + 0.487 = -0.107 \approx -0.112$).

The results for nominal value added growth are hard to interpret because the cross-section and the pooled estimations present conflicting evidence. The cross-sectional coefficients are always negative while the coefficients from the pooled estimations are always positive. Some coefficients are statistically significant, others are not. The differences stem from the fact, of course, that the negative

[17]Nordhaus (2008, p. 10) notes that coefficients close to –1 signify that "consumers capture virtually all the gains from technological change."

impact of sectoral productivity growth on relative price growth is stronger than its positive effect on relative real value added growth in the cross-section estimations, while this is the other way round in the pooled estimations. For the time being, the evidence on hypothesis (3) remains inconclusive. Fortunately, as will be argued below, the test of hypothesis (6) offers additional insights. Nordhaus finds a negative association between productivity growth and nominal value added growth. This is in line with results reported in Table 2.

Hypothesis (4) states that industries with above-average productivity growth have below-average labor input growth; therefore, their share in total employment will decline over time. For this hypothesis, the empirical evidence is relatively clear-cut. The coefficients on both labor and multi-factor productivity growth in the hours worked equation are thoroughly negative and mostly significant, which speaks in favor of Baumol's model. Unlike in the nominal value added equation, the coefficients do not differ systematically between the cross-section and the pooled estimations, although for the latter, they are normally lower in absolute value. The averaged coefficients found for the EU are somewhat higher in absolute terms then those reported by Nordhaus and in Table 2 for the U.S. Therefore it seems that European industries with relatively high productivity growth displace labor to a higher extent than their U.S. counterparts.

The penultimate column of Table 3 reports the estimated coefficients from regressions of the growth rates of labor compensation per hour on productivity growth, which should be insignificant according to hypothesis (5). Like Nordhaus, I find coefficient values that are mostly small in absolute value, and insignificant. There are two exceptions, however. In the pooled estimations, labor productivity growth has a significantly positive impact on wage growth in the full sample of industries and in the sample of well-measured industries. The two significant coefficients are almost three times as high as Nordhaus's highest significant coefficient (+0.115 for labor productivity and the 1948–2001 cross section of well-measured industries). Nevertheless, my estimates still imply that a percentage point increase in labor productivity growth will raise wage growth by at most a third of a percentage point. In conjunction with the results on hypothesis (1) this means that technical progress also leads to lower prices rather than higher wages in Europe.

The EU KLEMS database allows us to dig a bit deeper into the productivity–wage nexus. One important cause of wage growth is the change in labor composition, i.e. the shift of employment towards higher-paid high-skilled workers; and this shift also has a positive impact on productivity growth. EU KLEMS provides the necessary data to filter out this effect. Both labor compensation and hours worked are divided into three skill levels ("high," "medium," "low") in the database. Also, for each industry the contribution of labor composition change to labor productivity growth (in percentage points) is available. If we regress the growth rates of labor compensation per hour for each skill level on productivity growth minus the growth contribution of labor composition change, we will have eliminated the effect of changes in labor composition on both wage and productivity growth. Table 4 shows that after changes in the skill level are controlled for, we find evidence for a positive impact of productivity growth on wage growth especially for the medium skill level. For the other two skill levels, Baumol's

TABLE 4

Impact of Productivity Growth on Wage Growth for Three Different Skill Levels; Aggregate of EU15 Countries Excluding Greece, Ireland, Luxembourg, Portugal, and Sweden (EU15ex); Period: 1970–2005

| | $\widehat{w}$ | | |
|---|---|---|---|
| | High | Medium | Low |
| $\widehat{lp} - gclc$ | | | |
| 29 industries | | | |
| Cross section | 0.213* | 0.174* | 0.077 |
| | (0.111) | (0.089) | (0.083) |
| 3 sub-periods | 0.233 | 0.407** | 0.197 |
| | (0.170) | (0.192) | (0.173) |

*Notes*: lp = labor productivity (gross value added per hour worked, indices, 1995 = 100), gclc = contribution of labor composition change to labor productivity growth (percentage points), w = labor compensation per hour (millions of PPP-converted Euros).

Standard errors are in parentheses.

***, **, and *denote significance at the 1%, 5%, and 10% levels, respectively.

Estimates for constant terms not shown.

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

assumption that differences in productivity growth across industries have no impact on relative wage growth seems to hold water.

## 4.3. *Robustness Check: The Cases of Italy and Finland*

Figure 1 shows that there is a wide range of productivity growth rates across European countries. To investigate the question whether this heterogeneity has an impact on the validity of the Baumol–Nordhaus model, I will repeat the analysis from Section 4.2 for Finland and Italy, which are the countries with the highest and the lowest average labor productivity growth rate, respectively, over the period 1970–2005.[18]

Table 5 lists the coefficient estimates and their standard errors. If we compare the values for Finland and Italy with each other and with those for the EU15ex aggregate in Table 3,[19] we notice that the similarities clearly outbalance the differences. The coefficients in the price growth equation are always significantly negative for Italy. For Finland and the EU15ex they are significantly negative in 9 out of 12 cases. The coefficients in the real value added growth equation are always significantly positive except in the cross-section estimations for the broad industry groups. This is true for both Italy and Finland, and the EU15ex aggregate. For nominal value added growth, we find the peculiar sign change between the cross-section and the pooled estimations everywhere except for the Finnish well-

[18]Finland also had the highest average multi-factor productivity growth rate. Italy's MFP growth rate was among the bottom three over the period 1980–2005. An advantage of focusing on Finland and Italy is that for these two countries, MFP data are available back to 1970.

[19]Note that 1979, 1988, and 2000 also mark business cycle peaks for Finland and Italy.

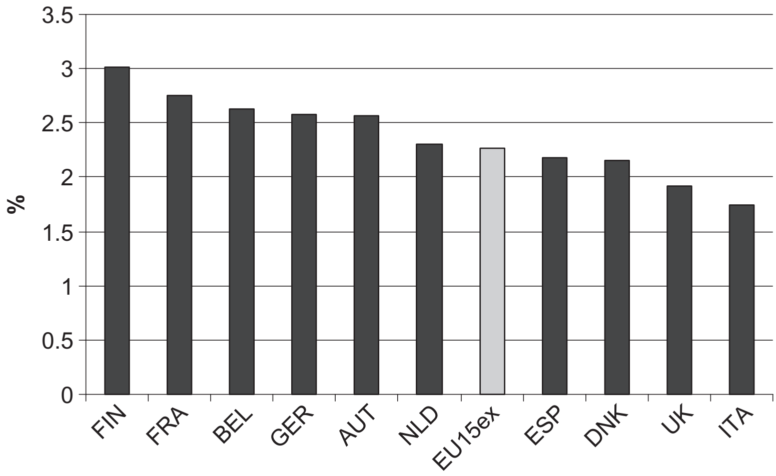


Figure 1. Average Annual Labor Productivity Growth in EU15ex Countries Between 1970 and 2005
*Source*: EU KLEMS data (www.euklems.net).

measured industries. The coefficients in the hours worked equation are always significantly negative for Italy. For the EU15ex aggregate and Finland, we register a number of insignificant coefficients, yet the evidence on hypothesis (4) is still predominantly supportive for the Baumol–Nordhaus model. The greatest differences can be found in the wage growth equation. In the case of Italy, all coefficients except one are significantly positive, suggesting that Italian industries with relatively high productivity growth show above-average wage growth. For Finland and the EU15ex aggregate it is less clear whether productivity growth has an impact on wage growth.

## 5. The "Growth Disease"

The task remaining is to test whether the European Union suffers from the "growth disease," i.e. whether structural change has a negative impact on overall productivity growth. Nordhaus suggests testing this hypothesis by weighting the industries' productivity growth rates with their value added shares in nominal GDP in alternative years.[20] If the stagnant industries gain weight—as Baumol's model suggests—then the overall productivity growth rate should be higher if earlier years are used as weighting (or base) years. In other words, Baumol's model predicts that updating the base year leads to a drop in the overall productivity growth rate. Nordhaus finds exactly this pattern in U.S. data.

Table 6 shows that a similar pattern emerges for the EU15ex aggregate. In the table, 2000, for instance, means that for each year 1971–2005 (1981–2005 for MFP), the productivity growth rates of the major industry groups are summed together to the overall productivity growth rate using the share of the respective

[20]He abstracts from the impact of differences between the input shares and the nominal output shares of industries on aggregate productivity growth.

TABLE 5

IMPACT OF PRODUCTIVITY GROWTH ON FIVE VARIABLES; COUNTRIES: FINLAND AND ITALY; PERIOD: 1970–2005

| | $\hat{p}$ | | $\widehat{rgva}$ | | $\widehat{ngva}$ | | $\widehat{hemp}$ | | $\hat{w}$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Finland | Italy | Finland | Italy | Finland | Italy | Finland | Italy | Finland | Italy |
| $\widehat{lp}$ | | | | | | | | | | |
| All industries | | | | | | | | | | |
| Cross section | –0.836*** | –0.796*** | 0.665*** | 0.356*** | –0.193 | –0.421*** | –0.329*** | –0.595*** | 0.012 | 0.082 |
| | (0.064) | (0.076) | (0.121) | (0.102) | (0.144) | (0.094) | (0.116) | (0.102) | (0.061) | (0.050) |
| 4 sub-periods | –0.145** | –0.690*** | 0.772*** | 0.738*** | 0.628*** | 0.177*** | –0.156*** | –0.264*** | –0.012 | 0.127*** |
| | (0.073) | (0.061) | (0.038) | (0.044) | (0.081) | (0.064) | (0.034) | (0.046) | (0.040) | (0.041) |
| Well-measured industries | | | | | | | | | | |
| Cross section | –0.881*** | –0.815*** | 1.002*** | 0.655*** | 0.103 | –0.141 | 0.004 | –0.221* | –0.083 | 0.132* |
| | (0.092) | (0.078) | (0.148) | (0.119) | (0.190) | (0.140) | (0.139) | (0.108) | (0.085) | (0.070) |
| 4 sub-periods | –0.040 | –0.498*** | 0.794*** | 0.749*** | 0.741*** | 0.276*** | –0.123*** | –0.241*** | –0.071 | 0.146*** |
| | (0.076) | (0.068) | (0.044) | (0.046) | (0.089) | (0.080) | (0.038) | (0.045) | (0.048) | (0.051) |
| Industry groups | | | | | | | | | | |
| Cross section | –0.805*** | –0.493*** | 0.196 | 0.009 | –0.615** | –0.493** | –0.789*** | –1.001*** | 0.106 | 0.336* |
| | (0.124) | (0.103) | (0.182) | (0.132) | (0.243) | (0.167) | (0.179) | (0.132) | (0.126) | (0.156) |
| 4 sub-periods | –0.193 | –0.445*** | 0.853*** | 0.514*** | 0.683*** | 0.109 | –0.135 | –0.498*** | 0.480*** | 0.435*** |
| | (0.164) | (0.121) | (0.167) | (0.083) | (0.241) | (0.148) | (0.163) | (0.085) | (0.122) | (0.094) |
| $\widehat{mfp}$ | | | | | | | | | | |
| All industries | | | | | | | | | | |
| Cross section | –0.876*** | –1.119*** | 0.845*** | 0.670*** | –0.034 | –0.385*** | –0.338* | –0.315** | 0.181* | 0.096* |
| | (0.083) | (0.072) | (0.212) | (0.110) | (0.226) | (0.108) | (0.193) | (0.141) | (0.090) | (0.051) |
| 4 sub-periods | –0.711*** | –1.020*** | 0.833*** | 0.864*** | 0.170 | 0.078 | –0.268*** | –0.187*** | 0.279*** | 0.112** |
| | (0.135) | (0.077) | (0.056) | (0.051) | (0.149) | (0.076) | (0.058) | (0.056) | (0.061) | (0.046) |
| Well-measured industries | | | | | | | | | | |
| Cross section | –0.822*** | –0.907*** | 1.372*** | 0.545*** | 0.558* | –0.352** | 0.224 | –0.448*** | 0.108 | 0.140* |
| | (0.132) | (0.078) | (0.285) | (0.159) | (0.307) | (0.158) | (0.243) | (0.154) | (0.135) | (0.074) |
| 4 sub-periods | –0.610*** | –0.726*** | 0.776*** | 0.826*** | 0.151 | 0.122 | –0.213*** | –0.292*** | 0.151* | 0.148** |
| | (0.107) | (0.079) | (0.071) | (0.065) | (0.144) | (0.108) | (0.070) | (0.061) | (0.076) | (0.061) |
| Industry groups | | | | | | | | | | |
| Cross section | –0.899*** | –0.523*** | 0.414 | 0.292 | –0.486 | –0.219 | –0.858*** | –1.053*** | 0.166 | 0.574** |
| | (0.225) | (0.152) | (0.271) | (0.198) | (0.332) | (0.241) | (0.252) | (0.336) | (0.210) | (0.201) |
| 4 sub-periods | –0.211 | –0.421*** | 0.728*** | 0.460*** | 0.532** | 0.055 | –0.166 | –0.604*** | 0.350*** | 0.472*** |
| | (0.166) | (0.148) | (0.176) | (0.106) | (0.249) | (0.213) | (0.165) | (0.138) | (0.120) | (0.227) |

*Notes*: lp = labor 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 (million PPP-converted Euros), hemp = total hours worked by persons engaged, w = labor compensation per hour (million PPP-converted Euros).

Standard errors are in parentheses.

***, **, 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 6
Average Fixed-Weight Labor and Multi-Factor Productivity Growth with Different Base Years for EU15ex Countries

| | Average Labor Productivity Growth Rate (1970–2005) | | Average MFP Growth Rate (1980–2005) | |
|---|---|---|---|---|
| Base Year | All Industries | Without Business Services | All Industries | Without Business Services |
| 1970 | 2.12% | 2.37% | – | – |
| 1975 | 2.02% | 2.28% | – | – |
| 1980 | 1.94% | 2.23% | 0.61% | 0.76% |
| 1985 | 1.88% | 2.22% | 0.57% | 0.75% |
| 1990 | 1.80% | 2.17% | 0.55% | 0.75% |
| 1995 | 1.69% | 2.08% | 0.49% | 0.70% |
| 2000 | 1.64% | 2.05% | 0.47% | 0.70% |
| 2005 | 1.58% | 2.00% | 0.45% | 0.68% |

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

industry group in nominal GDP in the year 2000 as weights. For each alternative weighting year, time series (quantity indices) for labor and multi-factor productivity result. Table 6 reports the average growth rates (geometrical means) for these series over the period 1970–2005 (1980–2005 for MFP) for different weighting (or base) years. Obviously, updating the base year reduces the average productivity growth rate for the overall economy, which means that the stagnant industries gain weight over time. Therefore, the EU15ex countries are also affected by the "growth disease." Just like in the U.S., structural change has a growth-dampening effect.

This finding helps to re-evaluate the thus far inconclusive evidence on hypothesis (3). If the stagnant industries gain weight, then the coefficients must be negative in the regression of nominal value added growth on productivity growth. In other words, in the sixth column of Table 3, the cross-section estimates seem to fit, while the estimates from the pooled estimations are for some reason misleading. Why this is so is hard to tell. Intuitively, estimates derived from pooled cross-section and time-series data might depart from those based on cross-sectional averages for the entire time period if there are opposing trends during the period. Such opposing trends indeed exist. For instance, Figure 2 shows the volume index of labor productivity for the industry group "renting of machinery and equipment and other business activities." This industry group is of particular interest because it has gained by far the most weight over the observation period. Its value added share almost tripled, from 4.0 to 11.6 percent, between 1970 and 2005.[21] If we look at the average productivity growth rate over the entire period, business activities are almost stagnant. Labor productivity rose by only 0.7 percent per year on average.[22] However, Figure 2 shows that between 1970 and 1983 things looked quite different. Labor productivity increased by 2.3 percent per year. Over the same period, the value added share of business activities rose by more than 2

[21]As a robustness check, I redid the test of hypothesis (6) excluding business services. Table 6 shows that the conclusion is not affected by the exclusion of this industry group.

[22]Multi-factor productivity went down by 1.6% per year on average over the period 1980–2005.

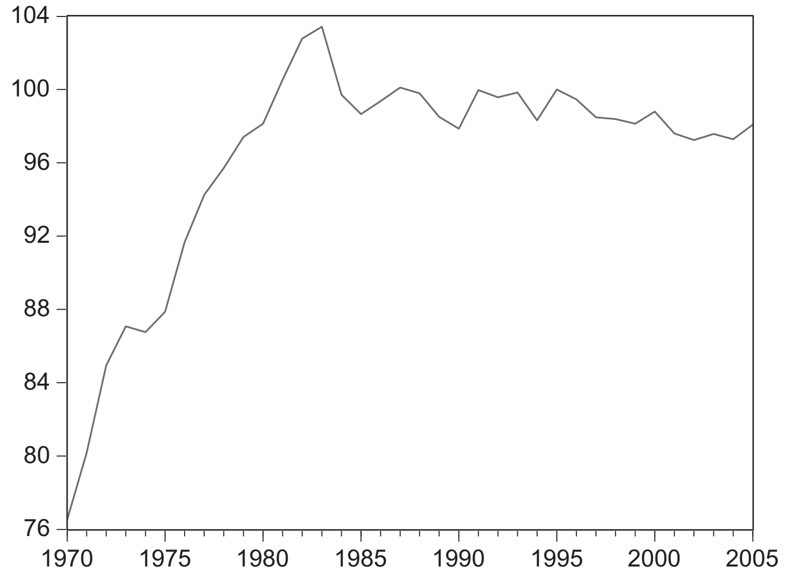


Figure 2. Volume Index of Labor Productivity of the Industry Group "Renting of Machinery and Equipment and Other Business Activities" (1995 = 100) for EU15ex Countries

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

percentage points. To what extent such opposing trends can explain the differences between the cross-section and the pooled estimations with EU KLEMS data—differences that are absent in Nordhaus's estimations with data from the Bureau of Economic Analysis—is a topic for further research.

## 6. Conclusion

Based on a new testing strategy, Nordhaus (2008) concludes that the U.S. economy is affected by a number of rather unpleasant by-products of structural change which—paying tribute to Baumol's (1967) seminal model of structural change—he chooses to call "Baumol's diseases." The aim of this paper is twofold. First, I intend to check the robustness of Nordhaus's findings by replicating his tests with U.S. data from different sources. While Nordhaus uses GDP-by-industry data published by the Department of Commerce's Bureau of Economic Analysis (BEA), I draw on EU KLEMS and STAN data. Although Nordhaus's main findings re-emerge from this robustness check, an even greater coherence between the results might have been expected. This warrants further research.

The second aim of the paper is to find out whether the European Union also suffers from "Baumol's diseases." Again, I draw on Nordhaus's testing methodology for Baumol's model and on EU KLEMS data, which I organize in a similar way as Nordhaus organizes his data. My results suggest that—just like the U.S.—the European Union suffers from the "cost and growth diseases." However, there are certain differences between my findings and Nordhaus's. For instance, there is evidence that relative productivity growth has a stronger impact on industries' relative real value added growth in the U.S. than in Europe. On the other hand, the drop in hours worked in the progressive relative to the stagnant industries could be more pronounced in Europe than in the U.S. Maybe—unlike in the U.S.—relative wage growth in European industries (at least in certain countries) depends on productivity growth. Furthermore, somewhat puzzling differences between coefficient estimates from pooled and from cross-section estimations—not present in Nordhaus's results—have been found in EU KLEMS data. These deserve further attention.

Despite these differences, the main upshot of the paper is that countries are similarly affected by "Baumol's diseases." This result might come as a surprise for many, given the huge known differences in market institutions between the U.S. and Europe or even between European countries. So why are the results so similar? I will not pretend that I know the answer already. We are just beginning to scratch the surface, it seems. However, one conclusion could be that the forces of structural change highlighted by Baumol's model are so strong and fundamental as to override institutional and other differences that may exist between (groups of) developed countries.

## Appendix: Industry Definition

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

### *All 46 Detailed Industries*

(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
Renting of machinery and equipment
Computer and related activities
Research and development
Other business activities
Public administration and defense; compulsory social security
Education
Health and social work
Sewage and refuse disposal; activities of membership organizations; recreational, cultural, and sporting activities; other service activities
Private households with employed persons

*16 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
Renting of machinery and equipment and other business activities
Public administration and defense; compulsory social security
Education
Health and social work
Other community, social, and personal service activities
Private households with employed persons

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