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U.S.-Europe Growth Differences: The Role of Education

1 Introduction[1]

After strong economic growth until the 1980s, European growth has become weak relative to that of the U.S.A. In addition, with the exception of a few countries, Europe has suffered from a "technology deficit" relative to the U.S.A. As measured by manufacturing productivity, the share of information technology (IT) investment or by the contribution of IT to output growth, European technology has lagged behind. These developments have happened against the background of an increased growth rate of technological progress embodied in new technologies, and a European tradition of fostering specialized, skill-specific, "vocational" education at the upper-secondary and tertiary level. While these concurrent events may have no causal link, in this paper we want to propose an alternative view, namely that the European focus on vocational education, while appropriate during the technologically tranquil times of the 1950s and 1960s, may have hampered European technology

[1] *This paper is based on our previous work, Krueger and Kumar (2004a, 2004b).*

Table 1

Growth Rates of Real GDP per Capita

	1970–1980	1980–1990	1990–1998	1999
	%			
U.S.A.	2.1	2.3	2.0	3.2
Germany	2.6	2.0	1.0	1.4
Italy	3.1	2.2	1.2	1.3
France	2.7	1.8	0.9	2.5
U.K.	1.8	2.5	1.7	1.7

Source: Scarpetta et al. (2000).

adoption and economic growth from the 1980s onwards. We thereby provide a novel explanation to U.S.-Europe differences when compared to the more conventional view that these differences can be attributed to labor and product market regulations.

In order to substantiate our hypothesis we proceed in four steps. In the next section we document the main motivating facts for our study: slow European growth since the 1980s, a technology deficit opening up compared to the U.S.A., and European focus on skill-specific, vocational education. Section 3 summarizes our main theoretical hypothesis and provides supporting empirical evidence for the two crucial assumptions underlying our hypothesis. Then, in section 4 and 5 we document and discuss the main theoretical and quantitative implications of our theory, before offering concluding remarks in section 6 of the paper.

2 The Facts

2.1 Evidence for Emergence of Growth Gap

In table 1 we present evidence for growth rates of real per capita GDP from the 1970s to the 1990s for the U.S.A. and a number of European countries. In most of our discussion we will focus on two countries in Europe, namely Germany and Italy, which quintessentially conform to our story, but a similar pattern can be seen for other European countries as well.

In the 1970s Germany (2.6%) and Italy (3.1%) had higher annualized per capita GDP growth than the U.S.A. (2.1%). In the 1980s, the U.S.A. grew at the faster rate of 2.3%, compared to 2.0% and 2.2% for Germany and Italy. The U.S.A. lead solidified in the 1990s; it grew at 2.0%, while Germany and Italy managed only 1.0% and 1.2%.[2]

In table 2 we present a different perspective on the same basic fact by documenting the evolution of rel-

[2] *Note that our theoretical analysis will have nothing to say on the faster growth of some European countries until the 1970s, since it does not feature any direct channel of international catch-up. Our aim is to explain why a region that was doing well slowed down and a gap emerged relative to the U.S.A., when the rate of available technologies actually increased. The theme voiced by Lawrence and Schultze (1987) is relevant in this regard: "The European economies...now experienced problems in graduating from a catch-up economy to one on the frontier of technology... Workers must have general training to adapt to new tasks, and European education, which has encouraged apprenticeships that provide specific skills, must adapt."*

Table 2

Per Capita GDP Relative to the U.S.A., Constant 1995 PPP U.S. Dollars

	1970	1975	1980	1985	1990	1995	2000
Germany	0.86	0.87	0.90	0.87	0.88	0.76	0.70
Italy	0.66	0.68	0.73	0.70	0.72	0.71	0.65
France	0.75	0.80	0.79	0.75	0.76	0.73	0.69
U.K.	0.67	0.68	0.65	0.64	0.66	0.66	0.63
EU	0.76	0.78	0.78	0.76	0.77	0.73	0.70

Source: CESifo (2002).

Table 3

Growth Rates in Output per Hour, Manufacturing

	1978–1984	1985–1991	1992–2002
	%		
U.S.A.	2.9	2.4	4.3
Germany	2.4	2.2	2.7
Italy	3.8	1.7	1.6
France	4.8	3.6	4.2
U.K.	3.5	4.6	2.9

Source: Bureau of Labor Statistics, "Output Per Hour in Manufacturing, 14 countries or areas, 1950–2002" and authors' calculations. For Germany the data until 1991 refer to West Germany, after 1991 to the whole of Germany.

ative GDP per capita for Europe, relative to the U.S.A. In general we observe that while Europe was catching up to the U.S.A. up until about the early 1980s, since then it has fallen behind, in terms of real GDP per capita. Evidently this reflects nothing else but the higher growth rates in the U.S.A., especially in the 1990s, that we documented in table 1.

2.2 Evidence for a New Productivity and Technology Usage Gap

Since our theoretical hypothesis focuses on technology adoption, productivity growth and technology usage might be more relevant indicators of economic performance for our purposes. Our model is most likely to apply to the manufacturing sector. Table 3 provides data on manufacturing output per hour relative to the U.S.A. The widening gap is clearly visible if one examines manufacturing labor productivity growth. The 1986–1990 and 1991–2000 figures for the U.S.A. are 2.4% and 4.3%, while those for the EU, while even higher during the early 1980s and comparable during the late 1980s, were significantly lower than in the U.S.A. in the 1990s (with the possible exception of France).

The gap between the U.S.A. and Europe is even starker when one examines technology-driven industries in the U.S.A., these industries recorded an average annual productivity increase of 8.3% in the 1990s, when compared to the 3.5% achieved in the same industries in the European Union.[3]

There is abundant direct evidence that Europe lags behind the U.S.A. in the usage of new technology. Schreyer (2000) presents results from growth accounting studies which show the contribution of In-

[3] *See page 66, Graph IV.5, and Table IV.6 in European Competitiveness Report (2001). Pharmaceuticals, Office machinery and computers, Motor vehicles, Aircraft and spacecraft, are a few of the industries classified as technology-driven industries.*

Table 4

ICT Contribution to Output Growth (Percentage Points)

	1980–1985	1985–1990	1990–1996
U.S.A.	0.28	0.34	0.42
Germany	0.12	0.17	0.19
Italy	0.13	0.18	0.21

Source: Schreyer (2000).

formation and Communication Technology (ICT) capital to output growth; these are presented in table 4.[4] The contribution of ICT capital to output growth has been increasing for all countries, but the gap between the U.S.A. and European countries has been increasing as well.

Bessen (2002) estimates that technology adjustment costs peaked in the U.S.A. at 90 cents per investment dollar during 1984–88, amounting to 10% of the manufacturing sector output. This is an indication of the high degree of costly technology adoption undertaken in the U.S.A. during this period. For evidence that increased usage of such technology improves productivity, we turn to Stiroh (2002), who conducts econometric tests using industry-level data to show that IT-intensive industries experienced significantly larger labor productivity gains than other industries; he also finds a strong correlation between IT capital accumulation and labor productivity.[5] Though the actual magnitude of the productivity boom in the U.S.A. during the 1990s continues to be debated (see, for instance, Gordon, 2000, for a skeptic's view), the facts that Europe has lagged behind the U.S.A. in the last two decades in technology usage and technology production, and experienced slower productivity growth, are unlikely to be overturned by recent evidence.

2.3 Evidence for Differences in the Educational System

Since we suggest the educational system as an important source of U.S.-Europe productivity and growth differences, we now present evidence on the European focus on vocational education. The classification of education into general and vocational should be viewed as a metaphor for the rigidity and inflexibility of European upper secondary and post-secondary education. The

[4] *The data from Schreyer (2000) uses an ICT price index harmonized across countries. Again, France and the U.K., the two other European countries for which data is presented, exhibit a similar pattern. When these figures are calculated in percentage terms instead of absolute percentage points, similar patterns persist. Schreyer, in his table 1, also presents data showing a similar widening gap in the share of IT equipment in total investment.*

[5] *A positive correlation between the ICT share and TFP growth also emerges from Graph 6 in the European Commission (2000) report. The widespread nature of productivity acceleration reported by Stiroh (2002) casts doubts on an alternate explanation for the U.S. productivity advantage, that the U.S.A. with its more liberal immigration policies attracts highly skilled specialists to the high-tech sectors. This would not explain why industries as far flung as Security and Commodity Brokers, not typically populated by immigrants, experienced huge increases in productivity growth. The assumption that only workers with high levels of general education immigrate to the U.S.A. is not tenable, and many immigrants first acquire general education in U.S. universities before they begin work. The immigration explanation also does not explain why there was a change in the U.S. economic performance starting in the 1980s without a concurrent significant change in U.S. immigration laws.*

Table 5

Education Indicators

	Austria	Finland	France	Germany	Italy	Nether-lands	Sweden	EU	U.S.A.
Fraction of students in upper secondary education that obtains general education	23	48	47	23	28	30	44	42.4	..
Fraction of students in upper secondary education that obtains vocational education	77	52	53	77	72	70	56	57.6	..
University net entry rate in % of cohort	26	..	33	27	..	34	..	..	52
Non-university tertiary attainment in % of population	2	9	8	10	..	..	14	..	8
University tertiary attainment in % of population	6	12	11	13	8	22	14	..	25
Non-university tertiary return in %	..	11	18	17	..	..	7	..	9
University tertiary return in %	..	15	14	11	10	11	8	..	13

Source: Education at a Glance: OECD Indicators (1997), tables C3.2, C4.1, A2.1, E5.1.

issue under consideration is broader than the distinction of college versus school education or overall attainment. In Europe, the channeling of students into either stream starts earlier than college; indeed, a portion of the differences in university enrollment between the U.S.A. and Europe can be attributed to such early pegging of students. One indication of such rigidity: in Germany only about 20% of university entrants are from the upper secondary vocational stream; the figure is 30% for France.[6]

Table 5 shows that in the EU, in 1995, more students were enrolled in the vocational stream (57.6%) at the upper secondary level than in the general stream (42.4%). In West Germany, 77% of upper secondary students and in Italy 72% were enrolled in vocational or apprenticeship programs. The emphasis on vocational education at this level is also evident for other European countries presented in table 5. In contrast, there is no separate stream of vocational education in the U.S.A. at this level; even the percentage of students who completed 30% or more of all credits in specific labor market preparation courses was just 6.8% in 1990.[7] Since education at this level is typically fully funded by the government, this data suggests that the European governments spend a greater fraction of their resources on vocational training than the U.S.A.[8] Vocational education in the U.S.A. is typically imparted in two-year community colleges; of those students over the age of 18 enrolled in post-secondary education, only 13.8% were working toward a vocational Associate's degree in 1991; this figure fell to 10.5% in 1994.[9]

Table 5 also presents the net entry rate into universities, where general education is primarily imparted; it is 52% in the U.S.A. but only 27% in Germany, 33% in France,

[6] *The figures are from OECD's "Education Policy Analysis" (1997).*

[7] *These figures are from table 3.2 of Medrich et al. (1994). Also see the European Commission's report "Young People's Training" (1998).*

[8] *The German apprenticeship program involves partial outlays by firms as well.*

[9] *See table 87 in Levesque et al. (2000).*

Table 6

Education Expenditures

	Austria	Finland	France	Germany	Italy	Nether-lands	Sweden	U.S.A.
Expenditure/GDP for primary and secondary education	4.2	3.7	4.4	3.7	3.5	3.1	4.5	3.7
Expenditure/GDP for vocational tertiary education	0.3	0.2	0.3	0.4	0.1	. .	. .	. .
Expenditure/GDP for university tertiary education	1.2	1.5	0.9	1.0	0.8	1.2	1.7	2.3
Expenditure per student for vocational tertiary education in U.S. dollars	7,245	5,776	7,636	10,924	6,283	7,592	. .	. .
Expenditure per student as % of per capita GDP for vocational tertiary education	31	27	36	48	36	31	. .	. .
Expenditure per student as % of per capita GDP for general tertiary education	11,279	7,582	7,113	10,139	6,295	10,796	. .	19,802
Expenditure per student as % of per capita GDP for university tertiary education	48	36	34	44	28	44	. .	61

Source: Education at a Glance: OECD Indicators (1997), tables B2.1c, B1.1 and B1.2.

and 26% in Austria. This lower European enrollment is reflected in attainment; while 25% of adults had completed university-level education and 8% had completed non-university tertiary education in the U.S.A. in 1995, in Germany only 13% had completed university education and 10% non-university tertiary education.[10] Except for the Netherlands, no other country comes close to the U.S.A. university attainment.[11] Incidentally, while the rate of return for men from such non-university tertiary education is 9% in the U.S.A., it is generally higher in Europe – as high as 17% in Germany and 18% in France. This differential might be an indication of better employment opportunities for the vocationally educated in those countries.

As seen in table 6, the allocation of educational resources also differs between the U.S.A. and continental Europe. The percentage of GDP devoted to primary and secondary education was comparable in the U.S.A. and the European countries in 1998. The 3.8% figure for the U.S.A. was well matched by 3.7% for Germany and 3.5% for Italy. However, the percentage devoted to university tertiary (general) education in the U.S.A. (2.3%) outstripped the percentages in Europe. For instance, Germany spent 1%, Italy 0.8%, and France 0.9%. The expenditure per student relative to GDP per capita on post-secondary non-tertiary (vocational) education was 48% in Germany for 1997, amounting to 10,924 purchasing power parity (PPP) dollars; little happens on this front in the U.S.A. The corresponding figures for university tertiary education were 44%

[10] *The OECD (2001, p. 129) identifies as vocational education non-university tertiary education as well as tertiary B programs with vocational education, imparting occupation-specific skills.*

[11] *Lazear's (2002) evidence that students who have taken a more general curriculum have a higher chance of becoming entrepreneurs is also relevant in this context. Entrepreneurship, which is an important channel for adoption of new technologies, is generally thought to lag behind in Europe relative to the U.S.A. See for instance, the European Commission's September 2001 policy paper "Entrepreneurial attitudes in Europe and the U.S."*

in Germany but 61% in the U.S.A. In PPP dollars, the university tertiary education expenditure per pupil was USD 10,139 in Germany while in the U.S.A. it was USD 19,802 (it was USD 6,295 in Italy).[12]

Expenditure per pupil in vocational tertiary education exceeds spending on university (general) tertiary education for Germany and the two are comparable for most of the other countries. This observation allows us to clarify our position – we do not claim education expenditure for all education is low in Europe as much as it is slanted toward a particular type of education, namely vocational education. This pattern holds not only for Germany and Italy, but also for other countries shown in table 6.

In summary, in this section we have documented three facts that motivate our theoretical analysis: slow European growth since the 1980s, a technology deficit opening up compared to the U.S.A., and European focus on skill-specific, vocational education.

3 Our Hypothesis and Supporting Evidence[13]

We submit the following hypothesis to explain the three stylized facts from the previous section. Europe's education policies provide higher relative incentives to obtain vocational, rather than general education. Vocational education enables workers to operative established technologies very productively, whereas general education enables workers to adapt more easily to new technologies. As long as the rate at which new technologies become available (the growth rate of embodied technological progress) is low, Europe's focus on vocational education is appropriate. But as this growth rate increases in the 1980s, more generally trained workers are needed to make it worthwhile for firms to adopt new technologies at the speed at which they become available. Now the American educational system is at an advantage, and a growth gap between the two regions may emerge.

Our theory has three basic economic decisions and two crucial assumptions that drive our results. Individual workers make the decision which type of education to attain, based on their innate talent to master general education and based on the relative wages a vocationally trained and a generally trained worker can command. Firms decide how many workers to hire and what level of technology to operate, where the latter choice is constrained by the technology frontier (that is, the best technology that is available). Our first crucial assumption is that workers with general education can efficiently operate new, but risky technologies, whereas vocationally trained workers are more efficient in operating old, established technologies. Our second crucial as-

[12] *Per-pupil expenditure figures appear to provide a more complete comparison of education focus. The percentage of total education expenditures in a given category that is public does not provide any indication of the actual level or intensity of funding. Similarly, a comparison of tuition would not be indicative of the actual burden faced by households. For instance, college education in most European countries is nominally free, but is funded out of high taxes levied on households.*

[13] *In this section we give a nontechnical account of our theoretical model; the exact details of the model as well as its theoretical and quantitative properties can be found in Krueger and Kumar (2004a, 2004b).*

sumption is that sometime in the 1980s the growth rate at which the *technology frontier* expands, increases, allowing (but not requiring) firms to increase the growth rate of the technology they *operate.*[14] Before presenting the theoretical and quantitative results implied by our theory, we want to briefly provide further supporting evidence for our two main assumptions.

3.1 Evidence that Education Helps to Cope with Technical Change

The notion that education helps in coping with technical change dates back at least to Nelson and Phelps (1966), who use reduced form specifications to postulate a higher return to education in an economy with more rapid technological change, and to Welch (1970), who provides supportive evidence for the dynamic advantage of education using wages of college graduates. While Welch (1970) uses R&D intensity as a proxy for technical change, Bartel and Lichtenberg (1987, 1991) use age of equipment as a proxy for lack of change and find that the labor cost share and the wage rate decrease with equipment age. Gill (1988) finds that higher total factor productivity (TFP) industries employ a larger proportion of educated workers and that the wage profile for highly educated workers shifts out with increasing TFP growth and is also steeper. Benhabib and Spiegel (1994) find that the human capital stock affects the speed of technology adoption in a cross-country context, lending support to a specification in Nelson and Phelps (1966). Thus, the advantage of education in adapting to technical change has both theoretical precedence and empirical support in the literature.

3.2 Evidence for Increase in Growth Rate of Embodied Technological Change

Our claim is that the emergence of a gap between the U.S.A. and Europe since the 1980s is related to the almost concurrent increase in the rate of technological change. There is ample evidence that investment-specific technological change indeed quickened by the 1980s. Cummings and Violante (2002) construct an aggregate index of investment-specific technical change and show that this index "grows at an average annual rate of 4% in the postwar period, with a sharp acceleration in the 1980s that leads to an average annual growth rate of more than 6% in the 1990s" (p. 245).[15] They also distinguish between the productivity of the best technology and the average practice, and claim this gap "... was 15% in 1975. In 2000, the figure had jumped to 40%" (p. 246). These facts motivate our thought experiment of increasing the growth rate of the frontier technology, to study whether such a change can lead to a growth gap opening up between the U.S.A. and Europe.

[14] *That is, our theory is one of exogenous technology innovation, but endogenous technology adoption.*

[15] *Greenwood and Yorukoglu (1997), Hornstein and Krusell (1996), and Krusell et al. (2000) arrive at a similar conclusion. While some of these studies identify the mid-1970s as the onset of the IT revolution, they also highlight delays that exist between the arrival of technologies and their impact on productivity. It, therefore, does not appear unreasonable for our purposes to consider the 1980s, which lies in between the advent of affordable computation in the 1970s and the IT boom of the 1990s, as the decade in which there was an upward shift in technological change.*

Empirical support for such an increase in growth rate of the frontier technology is also provided by Kortum and Lerner (1998), who examine patenting in the United States and find "applications for U.S. patents by U.S. inventors have risen more since 1985 (in either absolute or percentage terms) more than in any other decade this century ..." (p. 248–249, Figure 1). After having discussed the justification for our main assumptions we now proceed to describe the main implications from our theoretical model.

4 Theoretical Findings

In our theoretical model, newly born individuals optimally and irreversibly choose between one of the two streams of education mentioned above, based on their intrinsic ability to absorb conceptual education, anticipated market conditions, and government subsidies for the two types of education. They weigh the higher wages associated with operating newer technologies against the higher cost of acquiring general education. Firms have the choice of producing a single non-storable good either through technologies (production methods) *used* in the previous period – which have become well-understood and readily usable in the present period at no cost – or by adopting, at a cost, new technologies up to the available frontier. This technology frontier evolves exogenously. Non-adopting, "low-tech" firms can use the old technology without any adoption cost. The adopting "high-tech" firms have to pay a cost of adoption that depends on the distance between the new and the previously used level of technology in a convex fashion, as well as potentially higher wages to attract workers who face the risk of low task-specific productivity caused by their move to an unfamiliar and more complex technology.

We show that the equilibrium growth rate is weakly lower in an economy that allocates more of a given amount of resources toward vocational education. The positive relationship between the fraction of the work force with general education and growth may intuitively follow from our assumption that

only generally educated workers can operate new technologies, although demonstrating this requires a fully specified model such as the one we have developed. However, what is not obvious at all, is the effect of an increase in the rate of available technology; the true value of the model lies in showing that in such an event, countries with different education systems that had comparable growth rates initially (such as the U.S.A. and Europe) could diverge.

As the exogenous rate of technological change increases, higher net profits are needed to make it worthwhile for firms to adopt technologies at the new maximal rate. But this requires lower wages in the adopting sector, which in turn demands a larger share of the population be generally educated and supply their labor services to that sector. Therefore, Europe, having a lower share of the labor force with general education, may fail to sustain maximal growth, while the U.S.A. can more readily exploit the new technologies and might, in fact, be constrained only by their availability.[16] Our model suggests that while European education policies that favor specialized, vocational education may have worked well during the 1960s and 1970s when technologies were more stable, they may have contributed to slow growth and increased the European growth gap relative to the U.S.A. during the information age of the 1980s and 1990s when new technologies emerged at a more rapid pace.

The following observations made in the European Commission's European Competitiveness Report (2001) directly speak to the possibility of sluggish adoption of information and communication technologies (ICT), as well as a paucity of labor qualified enough to work with these new technologies: "The growing consensus that the strong growth and productivity performance in the U.S.A. is related to increased investment and diffusion of ICT goods and services has raised concerns that the weaker economic performance of EU Member States is caused by sluggishness in the adoption of these new technologies... in recent years skill shortages in important technology areas have been reported in several European countries ..." (p. 10–11).[17]

5 Quantitative Findings

How important is this education policy difference between the U.S.A. and Europe, compared to other explanations, in a quantitative sense? To answer this question, we extended our model above to incorporate labor and product market regulations, since these frictions are the most common explanations for the recent weak economic performance of Europe, relative to the U.S.A. Labor market frictions are modeled as firing costs for firms, whereas product market frictions are modeled as entry costs that have to be paid by firms out of their profits, conditional on deciding to produce output.

Our formalization of labor market rigidities and product market regulations has ample precedence in the literature. Pries and Rogerson (2001) use higher firing costs in Europe to capture labor market rigidities, which in their work increases the duration of unemployment through tougher hiring standards. Nagypal (2002) argues that high dismissal costs in Europe hinder learning about match quality and reduce average productivity. Our modeling of product market regulations as a cost is motivated by Nicoletti, Scarpetta and Boylaud (1999), who identify barriers to entrepreneurship as an important component.

[16] *We can also show that, within our model, relative wages of workers with general education increase with the increase in the rate of technological progress. The relative wage increase is more pronounced in the U.S.A. than in Europe, consistent with the data.*

[17] *The unemployment rate among adults with university education in OECD Europe was much lower in 2000 (4.1%) relative to the rates among those with just upper secondary education (7.2%) and those with less than upper secondary education (10%), see OECD Employment Outlook (2002). This provides further indication that the limited pool of labor with general education (university degrees) was readily employed. The corresponding figures for the U.S.A. were 1.8%, 3.6%, and 7.9%. Similar patterns are seen for most European countries for other years close to 2000.*

We then calibrate our model under the assumption that the U.S.A. adopts new technologies and grows at the maximal rate, irrespective of whether the exogenous rate of technological change is low or high. Therefore, observed U.S. manufacturing labor productivity growth rates equal the rates of exogenous technological change common to the U.S.A. and Europe. Given our choice of policy parameters for the U.S.A. and Europe based on independent empirical evidence, our empirical targets for assessing success of the model are European general education attainment and its productivity growth rate – roughly the same as that of the U.S.A. when technological change is low, but lower when technological change is high.[18] In other words, our choice of the exogenous rate of technological change enables, but by no means guarantees the *quantitative* success of our model.

Once we have established that the model performs well quantitatively, we use it to study counterfactual policies for Europe that would bridge its growth gap with the U.S.A. While a reduction in firing costs and (to a lesser degree) a reduction of regulation costs help to reduce this gap, a change in education policy explains most of it. More concretely, we aimed for explaining a growth gap of 1 percentage point between the U.S.A. and Europe in the 1990s. According to our model, 0.05 percentage points are explained by differences in product market regulations, 0.15 percentage points are explained by differences in labor market regulations and 0.6 percentage points are explained by differences in education policy.[19]

Our quantitative analysis with a calibrated version of our model shows that the role of education may be significant. Educational reform, in the form of higher flexibility in educational choices made at the upper secondary level, and a greater focus on general education might be important in reducing the U.S.-Europe growth gap that has emerged since the mid 1980s.

Finally we want to concede that our model may be geared towards finding a significant role for education. For instance, the education decision determines occupational choice forever. Relaxing this assumption would likely attribute a greater effect to labor market frictions and other impediments to occupational mobility. Indeed, it might be hard to completely disentangle the educational and labor market aspects in practice. Likewise, an explicit model of entry and entrepreneurship is likely to find a more important role for product market and other regulations.

6 Conclusions

In this paper we have argued that the recent growth gap between the U.S.A. and Europe may be partially explained by Europe's stronger focus on vocational education, compared to the U.S.A. If our hypothesis is valid, education reform towards more general education in Europe may have beneficial consequences for technology adoption and economic growth. There are signs that such

[18] *We focus on Germany and Italy for our calibration, as these countries' education systems are most different from the U.S.A. They are therefore ideal candidates for a quantitative investigation of our hypothesis.*

[19] *The remaining 0.2 percentage points are left unexplained by the model.*

reforms are underway; for example the planned introduction of bachelor programs at selected German universities, the introduction of the Swedish general training program "Kunskapslyftet" and many other initiatives. From the perspective of our research these are reforms in the right direction. ❧

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