Creativity, Talent, and Regional Wages in Sweden

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ABSTRACT: While there is consensus on the importance of human capital to economic development, debate takes shape around two central issues. First, there is the question of how best to measure human capital. Second, there is debate over the factors that yield the geographic distribution of human capital in the first place. We find that occupational or "creative class" measures tend to outperform educational measures in accounting for regional wages per capita across our sample of Swedish regions. Also, universities, service diversity, and tolerance affect the distribution of human capital, though in different ways and thus play complementary roles in the geographic distribution of talent.

Introduction

The role of talent and creativity in economic development has been the subject of growing interest and growing debate among economists, economic geographers, regional scientists, and other social scientists. Solow (1957) noted the effect of technology on economic growth. Lucas (1988) identified the role of human capital externalities in economic development. More recent research (Glaeser et al 1995; Glaeser 1998, 1999, 2000; Simon 1998) has empirically verified Lucas' conjecture regarding the role of human capital in regional development and growth. Berry and Glaeser (2005) have documented the growing divergence of human capital levels across U.S. regions over the past several decades. Florida (2002a, b, c, 2005, 2006) has argued for the need to better understand the factors that both produce human capital and enables regions to attract it, suggesting that human capital operates less as a static endowment or stock and more as a dynamic flow.

While there is broad consensus on the importance of human capital to economic development, the current debate revolves around two key issues. The first is how best to measure and account for human capital. The conventional measure of human capital is based on educational attainment, usually the share of a population with a bachelor's degree and above. More recent research suggests it is more important to measure what people do than what they study, and so occupationally-based measures, associated with the knowledge-based or creative occupations, have been introduced (Florida 2002a; Markusen 2004, 2006). A recent study (Marlets and Van Woerken, 2004) found that occupational measures of the creative class significantly outperform conventional human capital measures in accounting for regional development in the Netherlands.

Second, there is debate over the factors that affect the geographic distribution of human capital. At least three different theories have been offered. The first argues that universities play a key role in creating initial advantages in human capital, which becomes cumulative and self-reinforcing over time (Glaesar et al, 2005). The second argues that amenities play a role in attracting and retaining highly-educated, high-skill households (Glaeser 1993; Glaeser et al, 2001; Shapiro 2006; Clark 2003). The third theory argues that tolerance and openness to diversity are important (Florida 2002a, b, c). Our view is that these three approaches need not be seen as mutually exclusive. Each of these factors can play complementary a role in the distribution of talent.

To shed light on these issues, we develop a general model of talent and its effect on regional wages per capita as a measure of the absolute level of regional development, and use structural equations and path analysis models to examine the independent effects of human capital and technology on regional wage levels. We examine the factors that shape the geographic distribution of human capital across 81 Swedish regions.

The model enables us to do three things. First, it explicitly tests for the differential effects on regional wage levels of educational versus occupational measure of human capital or talent. Second, the model includes technology, the Solow factor, alongside talent, enabling us to parse the differential effects of each on wages per capita. Third, it tests for the effects of regional cultural and institutional factors – amenities, universities, and openness – on talent and turn on wage levels. Our dependent variable is regional wages per capita and our independent variables include measures of technology, educational and occupational talent, university presence, amenities (proxied by the diversity of service firms), and tolerance.

Across our sample of Swedish regions, we find that occupational or creative class measures tend to outperform educational measures in accounting for regional wage levels. We also find that universities have the strongest effect on the distribution of talent, amenities (i.e. service diversity), and openness and tolerance also play a role in the distribution of specific types of human capital. We conclude that the three play complementary roles in explaining the distribution of talent.

Theory and Concepts

The literature on economic development is vast. Solow (1957) noted the effect of technology on economic growth. Solow's model treated technology as exogenous and not affected by the marginal rate of substitution between capital and labor. Ullman (1958) noted the role of human capital in his work on regional development. Jacobs (1961, 1969) emphasized the role of cities and regions in the transfer and diffusion of knowledge; as the scale and diversity of cities increase, so do the connections between economic actors that result in the generation of new ideas and innovations. Andersson (1985a, b) explored the role of creativity in metropolitan regions for economic development. With a historical sweep reaching as far back as Athens, Rome, and Florence, he stressed the importance of knowledge, culture, communications, and creativity in regional prosperity. He also argued that tolerance plays a role in stimulating creativity in cities and regions. Romer's (1986, 1987, 1990) endogenous growth model connected technology to human capital, knowledge, and economic growth. Invention in the neoclassical framework is no longer exogenous, but a purposeful activity demanding real resources.

The endogenous growth model developed by Lucas (1988) further clarified the role of human capital externalities in economic development. Building on Jacobs' and Romer's work, Lucas (1988) highlighted the clustering effect of human capital, which now embodied the knowledge factor. He recognized the role of great cities, which localize human capital and information, create knowledge spillovers, and become engines of economic growth. Cities reduce the cost of knowledge transfer, so ideas move more quickly, in turn giving rise to new knowledge more quickly.

Research has empirically verified the role of human capital in regional growth. Barro (1991) confirmed the relation between human capital and growth on a national level. Glaeser (2000) provided empirical evidence on the correlation between human capital and regional economic growth. Firms locate in areas of high human capital concentration to gain competitive advantages, rather than letting suppliers' and customers' geography alone dictate their location. A vast economic research has also shown that human capital is becoming more concentrated (Florida 2002b; Berry and Glaeser 2005), and there are reasons to believe that this division will continue, affecting not only regional growth levels, but also housing markets (Shapiro 2005; Gyourko, Mayer, Sinai, 2006).

While there is broad consensus on the importance of human capital to economic development, the current debate revolves around two key issues. The first is how best to measure and account for human capital. The conventional measure of human capital is based on educational attainment – generally, the share of the population with a bachelor's degree and above. More recent research suggests it may be more important to measure what people do than what they study. Thus, occupationally based measures, associated principally with the knowledge-based or creative occupations, have been introduced (Florida 2002a; Markusen 2004, 2006). The educational attainment measure, it has been pointed out, leaves out a small but incredibly influential group of entrepreneurs, like Bill Gates or Michael Dell, who for various reasons did not go to or finish college. The educational attainment measure is also quite broad, and therefore does not allow for nations or regions to identify specific types of human capital or talent. A recent study (Marlets and Van Woerken, 2004) found that occupational measures of the creative class significantly outperform conventional human capital measures in accounting for regional development in the Netherlands.

Second, there is debate over the factors that affect the geographic distribution of human capital in the first place. Since we know that talent is associated with economic development, and we also know that talent is spread unevenly, it is important to understand the factors that account for this varied geography. Most economists currently conceptualize human capital as a stock or endowment, which belongs to a place in the same way that a natural resource might. But the reality is that human capital is a *flow*, a highly mobile factor that can and does relocate. The key question then becomes: What factors shape this flow and determine the divergent levels of human capital across regions?

Three different answers to that question have been offered. The first approach, offered by Glaesar and his collaborators (2005), is that human capital builds off itself. Places with an initial advantage tend to build on and gain from that advantage. The presence of major research universities has been found to be a key factor in this set of initial advantages as well in both the production and distribution of human capital.

Yet, the distribution of talent is not coincident with the distribution of universities. While some regions with great universities have large concentrations of talent, others operate mainly in the production of human capital, serving as "talent factories" which "export" highly educated people to other regions (Florida et al 2006). Florida (2005) has argued that the geographic connection from education to innovation and economic outcomes *in that same locale* may no longer hold. This is a result of the incredible mobility of highly-skilled and educated people within countries and even across borders. However good a region's educational system might be, it is no guarantee it can hold on to its talent. We suggest that the university can be thought of as a necessary but insufficient condition for talent concentration.

The second approach argues that the distribution of talent is affected by the distribution of amenities. Roback (1982) expanded the traditional neoclassical model, where migration occurs in response to wage levels, economic opportunity, and land rent to include quality-of-life amenities Glaeser, Kolko and Saiz (2001) found that consumer and personal service industries such as restaurants, theatres, and museums tend to be localized and thus demand geographical closeness between producer and consumer. Lloyd and Clark (2001) as well as Florida (2002a, 2002b, 2002c) stressed the role of lifestyle – in the form of entertainment, nightlife, culture, and so on – in attracting talent. Florida (2002c) introduced a measure of the producers of artistic and cultural amenities, the "bohemian index," and found it to be associated with concentrations of talent and innovation. Shapiro's (2006) detailed study of regional productivity growth found that "roughly 60 percent of the employment growth effect of college graduates is due to enhanced productivity growth, the rest being caused by growth in quality of life".

The third approach argues that tolerance and openness to diversity affect the level and geographic distribution of human capital. Jacobs (1961) and Quigley (1998) have argued that firm-based diversity is associated with economic growth, but Jacobs also argued that diversity of individuals is important as well. Recent research has focused on the role of demographic diversity in economic growth. Ottaviano and Peri (2005) show how diversity among individuals, in the form of immigrants, increases regional productivity. Immigrants have complementary skills to native born not because they perform different tasks, but also because they bring different skills to the same task. A Chinese cook and an Italian cook will not provide the same service nor good; neither will a German-trained physicist substitute perfectly for a U.S.-trained one. Noland (2005) found that tolerant attitudes toward gay and lesbians are associated with both positive attitudes toward global economic activity and international financial outcomes. In light of the results of his World Values Survey examines the relationship between cultural attitudes and economic development, Inglehart (2003, 2005) has said that openness toward to gay and lesbian population is the best indicator of the general tolerance of nations. Florida and Gates (2001) found a positive association between concentrations of gay households and regional development.

Page (2007) provides the basis for a general economic theory of human diversity and economic outcomes. He finds that not only does cognitive diversity lead to better decision-making but that it is associated with identity diversity, the diversity of people and groups, which enable new perspectives. Diversity broadly construed, he finds, is associated with higher rates of innovation and growth. Florida (2002) has argued that tolerance – specifically "low barriers to entry" for individuals – is associated with geographic concentrations of talent, higher rates of innovation, and regional development. The more open a place is to new ideas and new people – in other words, the lower its entry barriers for human capital – the more talent it will likely capture.

It is important to point out that these three institutional and cultural factors need not operate exclusively or in competition with each other. Rather, we suggest that they are likely to have complementary effects on the geographic distribution of talent. Such cultural and institutional factors may also act on regional economic development directly, as well as indirectly, via their effects on the level of human capital.

Model, variables, and methods

A schematic picture of our general model of talent, creativity, and regional wages per capita is provided in Fig.1. The model allows us to accomplish two useful analyses. First, it enables us to test conventional human capital measurements against occupational or creative class definitions simply by running the model with these differing definitions of talent. Second, it allows us to isolate the independent effects of talent and technology—Lucas versus Solow, if you will. The model also enables identification of regional cultural and institutional factors – namely, the university, amenities and service diversity, and tolerance – as they affect the geographic distribution of talent in the first place. The arrows identify the hypothesized structure of relationships among the key variables.

(Figure 1 about here)

Variables

We now describe the variables in the empirical model. The variables cover all 81 Swedish labor market areas, and are for the time period 2003 (except for the tolerance variable, from 2006). Descriptive statistics for all measures and variables are provided in Table 1.

Dependent variable: regional wage levels

The dependent variable in the model is a measure of wages per capita, the sum of the regional wages adjusted for regional population size. The wage measure we assume to be closely related to productivity - in particular to measure a region's capacity to absorb human capital productively. In our view it is a much better measure of regional development than commonly used measures such as population growth and job growth, which capture gross trends but fail to capture the quality of economic development. Not all jobs are created equal. There is considerable variance in human capital and skill levels. And of course wages vary accordingly. Furthermore, recent research shows that regions increasingly specialize in different kinds of economic activity, and therefore different kinds of jobs (Markusen 2004, 2006). In using wages to measure regional development, we prefer to use wages per capita to capture the overall level of development within and across regions. While wages per capita is not a perfect measure of overall living standards, it is a reasonable proxy for the achieved level of regional development.

(Table 1 about here)

Independent Variables

Talent

As noted above, there are two alternative measures of talent or human capital. The first is the conventional measure based on educational attainment, measured as the percentage of a population with a bachelor's degree and above. The second is an occupationally-based measure of the creative class. Several studies have shown the efficacy of this occupationally based measure (Markusen 2004, 2006; Marlets and van Woorken, 2004).

Florida (2002a) defines the creative class to include occupations in which individuals "engage in complex problem solving that involves a great deal of independent judgment and requires high levels of education or human capital." This includes a "super-creative core" – composed of computer and math occupations; architecture and engineering; life, physical, and social science; education, training, and library positions; arts and design work; and entertainment, sports, and media occupations – as well as other "creative professionals," akin to classical knowledge workers, including management occupations, business and financial operations, legal positions, healthcare practitioners, technical occupations, and high-end sales and sales management. We employ both the standard definition of the super-creative core and a narrow definition which excludes educational occupations. We also decompose the super-creative core to isolate the independent effects of its five sub-groups on regional wage levels and to identify the factors that affect their concentrations. All talent variables are measured as shares of the regional labor force (population age 16-64). The measures are based on 2003 education and occupation data from Statistics Sweden.

Technology

We include a technology variable to account for the independent effects of technology on regional development. The measure is a location quotient that takes into account the technology industry national share and its relation to the technology industry regional share. This is based on 2003 establishment industry data from Statistics Sweden.

Regional Institutional and cultural factors

The distribution of talent or human capital has been found to be associated with universities, tolerance, and amenities or service diversity. We include measures of all three variables in our model and analysis.

Universities: Since universities play a significant role in the production of talent, we may expect an overrepresentation of talent where universities are located. Also, since propensity to migrate is low in Sweden, role of the Swedish university might play an especially important role as a regional talent magnet. Swedish universities often have small branches in other nearby regions. To exclude those the university measure is a dummy variable equal to 1 (otherwise 0) if the number of university teachers is 100 or more (based on the occupational frequencies), in order to capture if there is an existing regional university with a size large enough to influence. The measure is based on 2003 occupational data from Statistics Sweden.

Amenities and service diversity: Getting systematic measures of cultural and recreational amenities, as the literature has noted (see esp. Florida 2002a) is fraught with problems, so here we follow Glaser, Kolko and Saiz (2001) and utilize the diversity of consumer and personal service firms as a proxy measure for amenities. Regions that offer a greater array of services have more to offer diverse groups of people. This variable is operationalized as the number of service industry codes represented within the local labor market that could be regarded as attractive to consumers. It is based on 2003 industry data from Statistics Sweden.

Tolerance/ Diversity: Diversity has been found to impact economic development in two ways. As noted above, we utilize a measure of service diversity to capture firm-based diversity (Jacobs 1961; Quigley 1998). There is also the effect of individual-level diversity. Immigration is a commonly use measure of diversity. But Sweden has a much lower level of immigration than countries like U.S. and Canada where there is also more variance in the concentration of immigrants across regions. Following Inglehart's (1989, 1997, 2003, 2005) finding that openness toward the gay and lesbian population is the best available indicator of tolerant attitudes currently available, we use a measure of attitudes toward gays and lesbians to capture tolerance and openness to diversity. In line with this, we argue that diversity within regions – in this case, the concentration of gay and lesbian households – creates a more open-minded and tolerant cultural, social, and economic milieu. Multiple perspectives and different kinds of people are more likely to flourish in such places, thus affecting both the geographic distribution of talent and also technology and regional development outcomes more directly.

Our tolerance measure is based on an index published in 2006 by the Swedish Federation for Lesbian, Gay, Bisexual and Transgender Rights which ranks Swedish municipalities. No index has been published for 2003 and this 2006 index will serve as a proxy, also with an assumption that regional tolerance levels do not change drastically over a short period of time. Since we use the local labor market level, we take the maximum municipality ranking within each region. In a majority of the observations, this is equal to the tolerance value of the core municipality within the local labor market. The reason for doing this is quite intuitive. We assume that those who move intra-regionally maintain access to what is available in the core municipality.

Indeed, access to core region amenities, might explain a person's regional location decision. There is a risk that we would have neutralized for this effect, had we used weighted average of all municipality scores within the local labor market,

Methods

We use path analysis and structural equations to examine the relationships between variables in the model. Structural equation modeling (SEM) is used in order to analyze the dynamics between the set of variables adequately. SEM may be thought of as an extension of regression analysis and factor analysis, expressing the interrelationship between variables through a set of linear relationships, based upon their variances and covariances. In other words, SEM replaces a (usually large) set of observable variables with a small set of unobservable factor constructs, thus minimizing the problem of multicollinearity (further technical description in Jöreskog, 1973). The parameters of the equations are estimated by the maximum likelihood method, using Amos software. To check that the estimations are robust, and because of the small number of observations, we also estimate the path analysis using a partial least square (PLS) method developed by Wold (1980, 1982; for further technical description, see Lohmöler, 1989). PLS combines multiple regression and principal component analysis, and can be calculated with lower sample sizes. However, it does not allow for correlations between the explanatory variables (as is our case in equation 1) as the Amos estimations. Based on this, we will still use the maximum likelihood estimation and use the PLS to check the robustness of these estimations, using the SmartPLS software.

It is important to stress that the graphic picture of the structural model (Fig.1) expresses direct and indirect correlations not actual causalities. Rather, the estimated parameters (path coefficients) provide information on the relation between the set of variables. The relative importance of the parameters is expressed by the standardized path coefficients which allow for interpretation of the direct as well as the indirect effects. We do not assume any causality among university, tolerance, and service diversity but rather treat them as correlations.

From the relationships depicted in the model (Fig.1) we estimate three equations:

$$Talent = \beta_{11} University + \beta_{12} Service\ Diversity + \beta_{13} Tolerance + e_3 \quad (1)$$

$$Technology = \beta_{21} Universities + \beta_{24} Talent + e_2 \quad (2)$$

$$Regional\ Wages\ per\ Capita = \beta_{31} University + \beta_{34} Talent + \beta_{35} Technology + e_1 \quad (3)$$

Findings

We begin by providing a general picture of the geographic distribution of technology, talent, creativity, and other economic, social, and cultural resources in Sweden. We then turn to the results of the path analysis and structural equations models.

The geographic distribution of talent, technology, and creativity is highly uneven and concentrated. Table 2 shows the regional distribution of population, technology, human capital, and various measures of the creative class for leading Swedish regions. Stockholm, home to roughly 22 percent of the Swedish population, accounts for 28 of wages, 30 percent of human capital and the national creative class, and 41 percent of technology. The top three regions account for 39 percent of the population, but roughly 46 percent of wages, 50 percent of the creative class, 52 percent of human capital, and 59 percent of technology.

(Table 2 about here)

Table 3 is a correlation matrix for the major variables. There are significant correlations among human capital, the creative class, technology, and regional wages per capita. The correlation between the creative class and regional wages (.703) is considerably higher than that between human capital and regional wages (.420). The correlation between the creative class and technology (.764) is also higher than that between human capital and technology (.655).

(Table 3 about here)

Figure 2 provides scatter-graphs which further compare the efficacy of the creative class and conventional human capital measures. The scatter-plots chart the relationship between these two talent measures and two key variables – technology and regional wages per capita.

(Figure 2 about here)

On the plots for the two talent measures and regional wages per capita, the regression line for the creative class is clearly steeper, and there are fewer outliers. The same pattern holds for the relationship between the two talent measures and technology. Nearly all of the regions with higher shares of creative class employment also have higher than predicted location quotients for technology. This is not the case for human capital, where the three top regions actually fall below the predicted value. The creative class measure, according to these analyses and the correlation matrix, outperform the conventional human capital measures in accounting for both technology and regional wages per capita.

Results from path analysis and structural equations models

To further gauge the differential effects of human capital and the creative class on regional wages per capita observe the results of the path analysis and structural equations models. We begin the model for conventional human capital and follow with the model for the creative class. We then introduce models for two definitions of the super-creative core and additional models for the key occupations that make up the super-creative core: computer and math; scientific occupations; engineering; education; and arts, design and entertainment. The models examine the effects of the various measures of talent on technology and regional wages and also isolate the effects of three key factors – universities, service diversity, and tolerance – on the level and geographic distribution of talent.

A path analysis is provided for each definition (also in appendix 1) of talent based on the standardized β-coefficients. This standardized coefficient is based upon the regression where all the variables in the regression have been standardized first by subtracting each variable's mean and dividing it by the standard deviation associated by each variable. This coefficient can be used to analyze the relative importance of the explanatory variables in relation to the dependent variable. Also, the other structural equation results are reported for.

Model 1: Conventional human capital

We begin with the findings for the model based on the conventional measure of human capital (share of the population with a bachelor's degree or above). As Table 4 shows, conventional human capital does not have a direct effect on regional wages per capita; the coefficient is negative and non-significant. Instead, conventional human capital works indirectly through its interaction with technology. The coefficient between technology and regional wages per capita is positive and significant, as is the coefficient between conventional human capital and technology. In other words, human capital works in combination and through technology to affect regional wages per capita.

Turning next to the factors associated with concentrations of conventional human capital, our findings indicate that the university plays the strongest role. In fact, the university tends to play a strong role across the board in this model, with coefficients that are positively and significantly related to technology and regional wages per capita as well as to human capital. The coefficients for service diversity and tolerance are also both positively and significantly related to human capital.

(Table 4 about here)

Model 2: Creative Class

The coefficient between the creative class and regional development is positive and significant, as Table 5 shows. This stands in contrast to the result for conventional human capital. The coefficient for the creative class is also positively and significantly associated with technology. Technology is not associated with regional wages per capita. The creative class acts directly on both technology and regional wages per capita.

Looking at the factors that are associated with the creative class, the coefficients for the university and service diversity are positive and significant, while the coefficient for tolerance is not. The university no longer plays a direct effect on either technology or regional wages per capita as that effect is apparently picked up by the creative class.

(Table 5 about here)

Model 3: Creative Professionals

We now look at the findings for sub-components of the creative class. Let's start with creative professionals who include occupations spanning finance, health-care, law, and education. As Table 6 shows, creative professionals, like the creative class more generally, have a direct effect on both technology and regional wages per capita. Neither technology nor the university has a direct effect on regional wages. Service diversity is the only factor that is positively and significantly associated with the level and distribution of creative professionals.

(Table 6 about here)

Model 4: Super-creative core

The super-creative core, composed of scientists and technologists, artists, designers and entertainers, has been seen as defining the innovative cutting-edge of capitalism. As Table 7 shows, the coefficient between the super-creative core and regional wages per capita is negative and insignificant, while the coefficient between it and technology is positive and significant. Thus, like conventional human capital, the effect of the super-creative core on regional development appears to occur indirectly through its interaction with technology. Also as in the model for conventional human capital, the university plays an important role being positively and significantly related to technology and regional wages per capita as well as to the super-creative core. The coefficients between the super-creative core and tolerance and service diversity are insignificant. All in all, the university plays a sizeable role in this model.

(Table 7 about here)

The super-creative core is composed of distinct subgroups, some of whom – engineers and computer and math professionals, for example – may be thought of as more closely linked to technology and regional wage levels. We ran models for each of the five major sub-groups that compose the super-creative core: computer and math, the sciences, engineering, education, and the arts and summarize the key findings below.

Education-related occupations

Table 8 presents the findings for the education sub-group. The coefficient between it and technology is insignificant. The coefficient between it and regional wages per capita is negative and significant. The education occupations thus appear to have a negative effect on regional wage levels. Even though a large share of this group is primary and secondary-level teachers, this finding is interesting, as it stands in contrast to a great deal of the conventional wisdom on the relationship between education, innovation, and economic growth. The low R^2 level for equation 1 indicates that the three explanatory variables do not explain much of the wage distribution of the educational occupations. This may reflect the fact that education is a public good. The distribution of educational occupations is thus far less specialized than other occupations, and wages will be relatively constant across regions.

In the main, it is assumed that innovation and economic growth require strong educational systems. Study after study in Sweden, the European Union, the United States and elsewhere have argued that strong education is a prerequisite of robust innovation and economic growth. But Florida (2005) has shown that the mobility of human capital has broken the connection between regional education and regional development at least to some degree. Furthermore, since education is a public good in Sweden, the distribution of these occupations is relatively uniform. In fact, there is likely to be a relatively larger share of education-related occupations to other creative occupations in Swedish regions with lower levels of regional development. Our findings should not be taken as implying that education spending is ineffective. While we find no connection between regional education and regional wages per capita, the benefits from education investment are not lost, but carry over through mobility of people and other mechanisms to higher-growth regions and to the national level generally.

(Table 8 about here)

Super-creative core without education

In light of these results, we re-ran the model for the super-creative core without the education-related occupations. Table 9 summarizes the key findings here. The coefficients for this redefined super-creative core are now positively and significantly associated with both technology and regional wages per capita. This is a considerable change from the model for the original definition of the super-creative core where the coefficient for it and regional wages per capita was insignificant. The refined super-creative core also appears to now overwhelm both university and technology variables in relation to regional wages per capita. Looking at the factors associated with the distribution of the super-creative core, service diversity now plays a considerable role alongside the university.

(Table 9 about here)

Computer and Math occupations

Computer and math occupations are thought to have a strong direct connection to innovation and economic growth. But as Table 10 shows, the findings indicate that their effect on wages is indirect, operating through technology. The coefficient for computer and math occupations and regional wages per capita is insignificant, while the coefficient between them and technology is positive and significant. The university plays a considerable role in this overall model, being positively and significantly related to regional wages per capita and technology, as well as to computer and math occupations. This is the occupational subgroup with the most skewed distribution. Forty-six percent is concentrated in just one region – Stockholm. This suggests considerable agglomeration effects for both firms and talent in this segment.

(Table 10 about here)

Scientific occupations

It is also often argued that scientific occupations are key contributors to technological innovation and economic growth. Table 11 shows the findings for the scientific occupations encompassing the physical, life and social sciences. The coefficient between scientific occupations and regional wages per capita is insignificant. Yet again, the effects of these occupations on development appear to work indirectly via technology. The coefficient between the scientific occupations and technology is positive and significant. In this model, the university again plays an important role in technology and regional wages per capita, though it is not associated with these occupations directly. Service diversity is the only regional factor significantly explaining it.

(Table 11 about here)

Engineering and architecture

Engineering has long been seen as a very important source of technological innovation and economic growth. Not surprisingly, engineering and architecture occupations are positively and significantly associated with both technology and regional wages, as Table 12 shows. Service diversity is a main factor associated with the concentration of these occupations. The university plays a role in this model being positively and significantly associated with both technology and also to some extent related to regional wages per capita. Surprisingly, it is not associated with clusters of engineering-related occupations.

(Table 12 about here)

Arts, design and entertainment

Artistic and cultural occupations are typically thought of as consumers, as opposed to producers, of resources. Our findings for arts, design, entertainment, and media occupations confound this conventional wisdom, as Table 13 shows. The coefficients for arts-related occupations are positively and significantly related to both technology and to regional wages per capita. Its effects on these two factors are roughly as significant as for the engineering-related occupations – and more significant than for the math, computer, and scientific occupations. Also of interest are the factors that are associated with the level and geographic distribution of the artistic occupations. The university no longer plays a significant role. Here, the largest standardized coefficients are tolerance and service diversity, both significant and approximately on the same level.

(Table 13 about here)

We have examined how the distribution of talent is affected by the regional environment with a focus on: universities, amenities (i.e. service diversity), and tolerance. The university factor tends to be the most influential overall, and in terms of its impact on technology and regional wage levels. Service diversity and tolerance also seem to play significant roles in the economic ecosystem. Service diversity is significantly related to the traditional, education based human capital, the creative class, creative professionals as well as several of the super-creative core occupational groups. Tolerance tends to play a significant role in the distribution of human capital as well as the concentration of arts, design and entertainment occupations.

All the talent groups except education occupations were directly related to regional technology levels. We also identified a difference between the education based human capital and the creative class. The creative class was directly related to regional average wage levels, while human capital was only related to average wage levels through the technology factor.

All regressions in the path analysis were also run including population as explanatory variable to rule out size effects. The population variable was significant, but did not change the R^2-values significantly. Also, due to the low number of observations, we also run all the regressions using partial least square, for robust checks. The results from these estimations were identical with the results from the Amos maximum likelihood estimations reported for in the paper.

Conclusion

Our research has examined the role of talent and creativity in relation to regional wage levels. We advanced a general model for an absolute level of regional development in terms of wages per capita, where regional institutional and cultural factors affect the distribution of talent and the concentration of talent in turn affects technology and regional wage levels. We ran the model for several definitions of talent and human capital, using path analysis and structural equations models to focus on two issues of considerable importance.

First, we compared the performance of occupational measures like the creative class, super-creative core, and others against more conventional educational attainment measures in accounting for regional wages per capita. Our overall findings indicate that the occupational or creative class measures outperform the conventional educational attainment measure, at least in the case of Sweden. They also indicate that occupations in the arts and culture, which have not typically been associated with regional development, play a significant direct role in the process. We should note that our overall findings are in line with those of Marlets and Van Woerken (2004), who suggest that such occupational measures may well set a "new standard" for measuring human capital and at minimum deserve more attention in empirical studies of regional and cross-national development.

Second, we examined three factors that have been seen to affect the distribution of talent and human capital: universities, amenities (i.e. service diversity), and tolerance. Generally speaking, our findings indicate that the university plays the most important role across the board, being significant in many versions of the model. This is in line with the findings by Berry and Glaeser (2005) and Florida (2006). The university plays a significant direct role in technology and regional development in several versions of the model as well. This suggests that the university is a central hub institution of the talent-driven creative economy, and crucial to talent, technology, and regional development.

Our research further suggests that service diversity and tolerance also play significant roles in the geographic distribution of talent. Service diversity is significantly related to the distribution of conventional human capital, the creative class, creative professionals, and several permutations of the super-creative core. Tolerance is significantly related to conventional human capital as well as to arts, design, and entertainment occupations. It is important to point out that all three regional attraction factors correlate strongly with one another. This leads us to suggest that these factors do not operate in competition with one another, but tend to attract or affect different types of talent. They can be thus said to play complementary roles in the geographic distribution of talent.

Generally speaking, our findings seem to suggest that the structure of relationships between the above factors, talent, and regional development is more complicated and differentiated than previous approaches have allowed. We look to future research on Sweden, the United States, and other countries to advance our understanding of how these factors and mechanisms work to condition economic development and living standards in regions and nations across the globe.

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Appendix 1: Path illustrations:

Model 1: Human Capital (BA university degree or more)

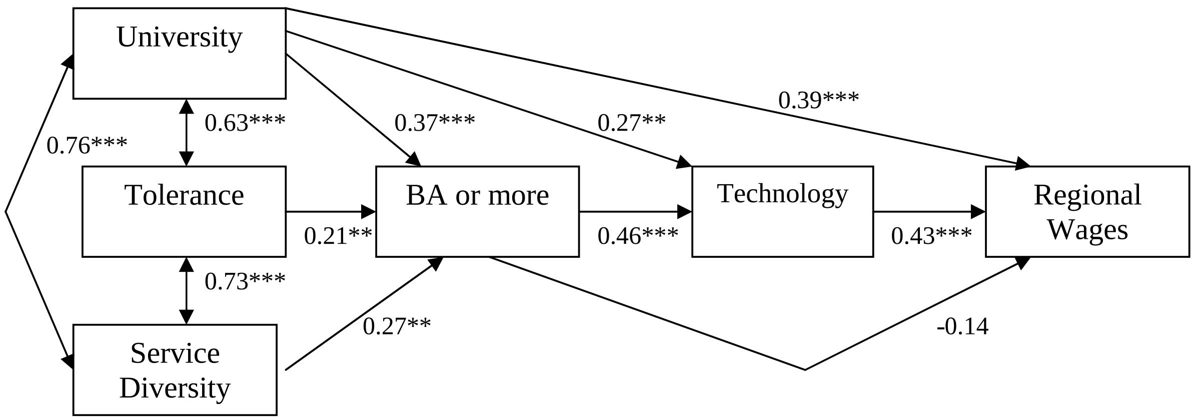


Figure 1: Path analysis for human capital

Model 2: Creative Class

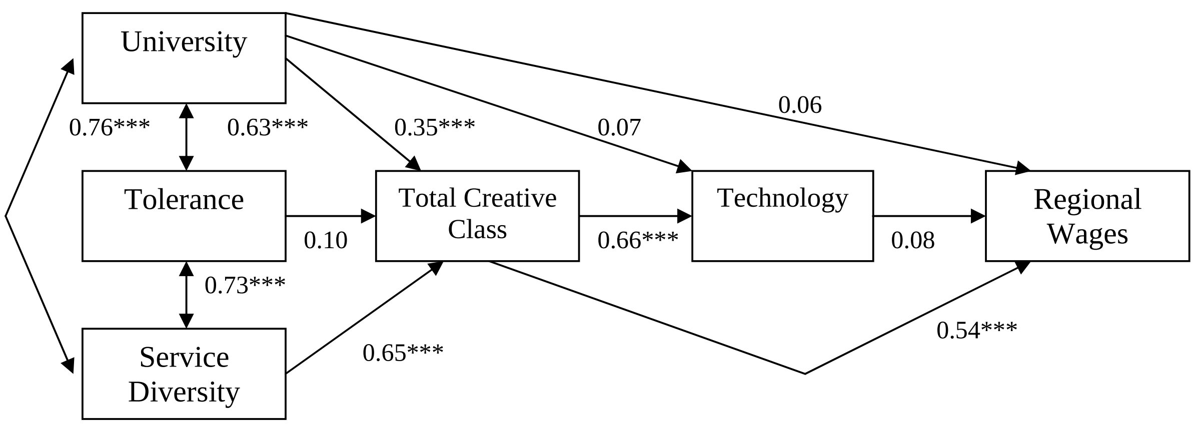


Figure 2: Path analysis for creative class

Model 3: Creative Professionals

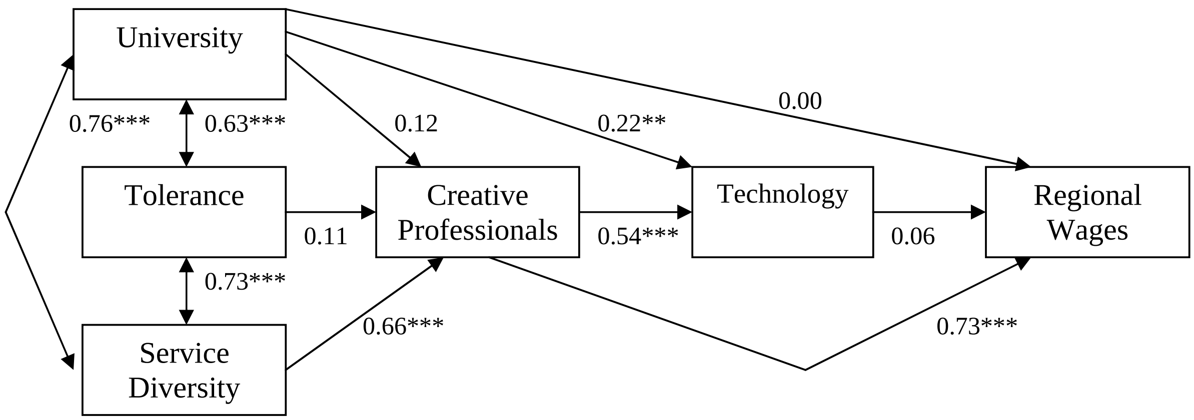


Figure 3: Path analysis for creative professionals

Model 4: Super-creatives

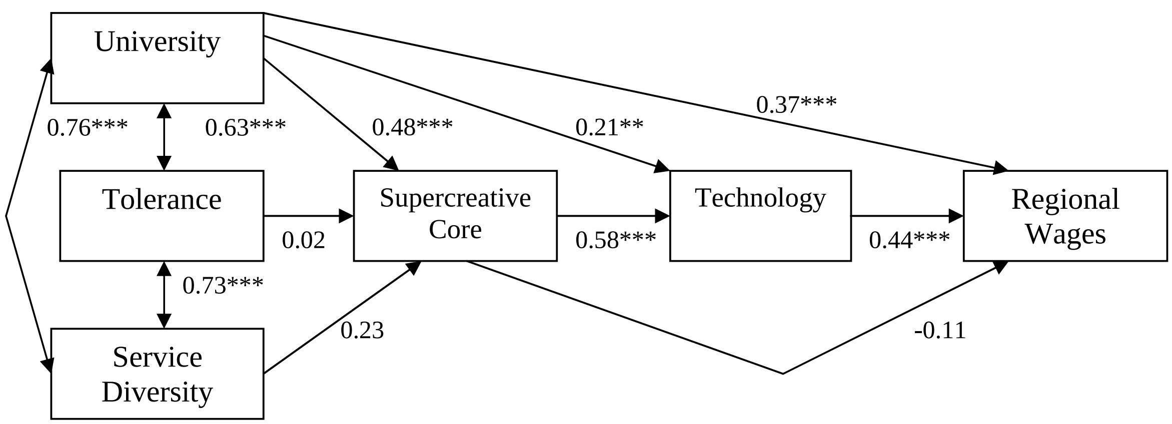


Figure 4: Path analysis for super-creative core

4.1. Decomposing the super-creative class:

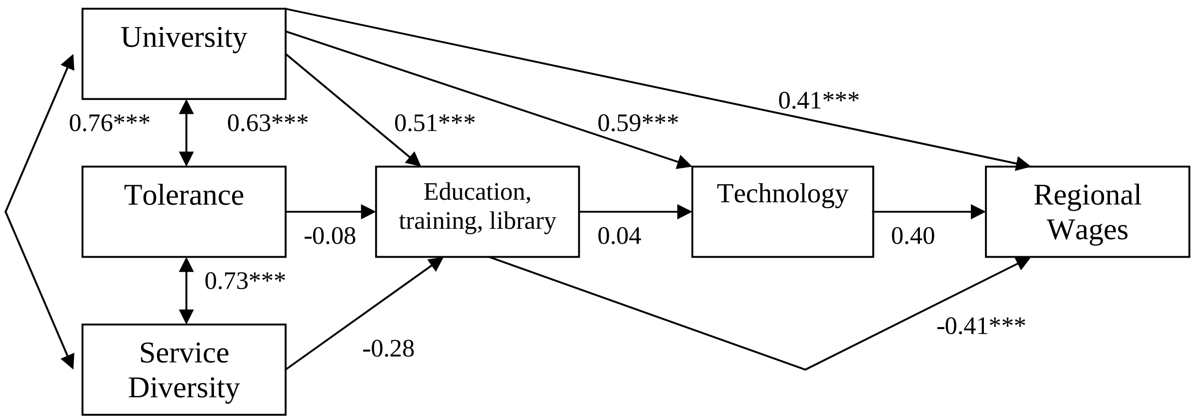


Figure 5a: Path analysis for education-related occupations

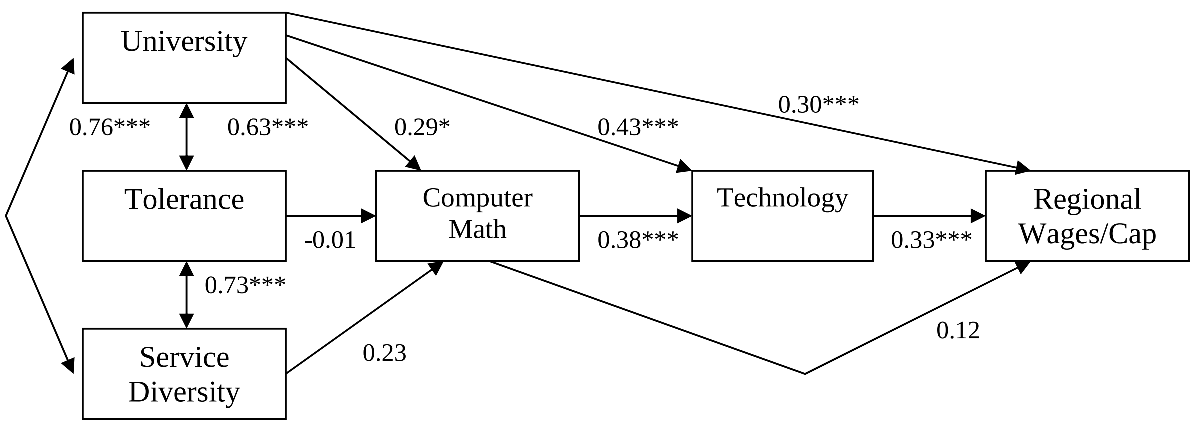


Figure 5b: Path analysis for computer and math occupations

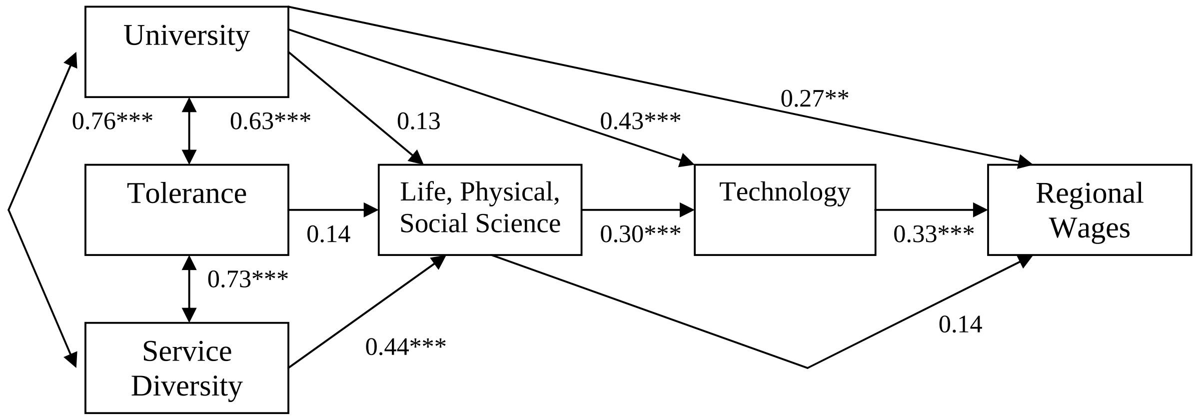


Figure 5c: Path analysis for life, physical and social science occupations

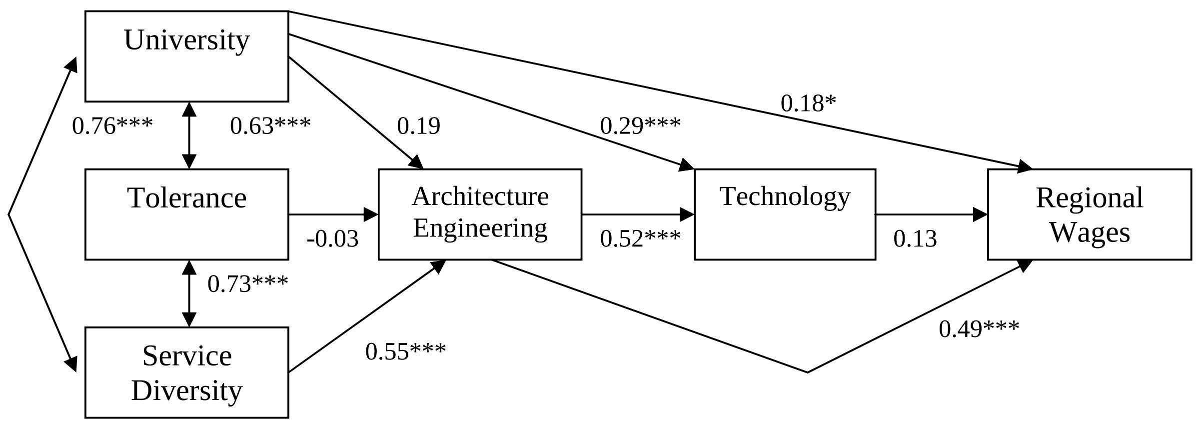


Figure 5d: Path analysis for architecture and engineering occupations

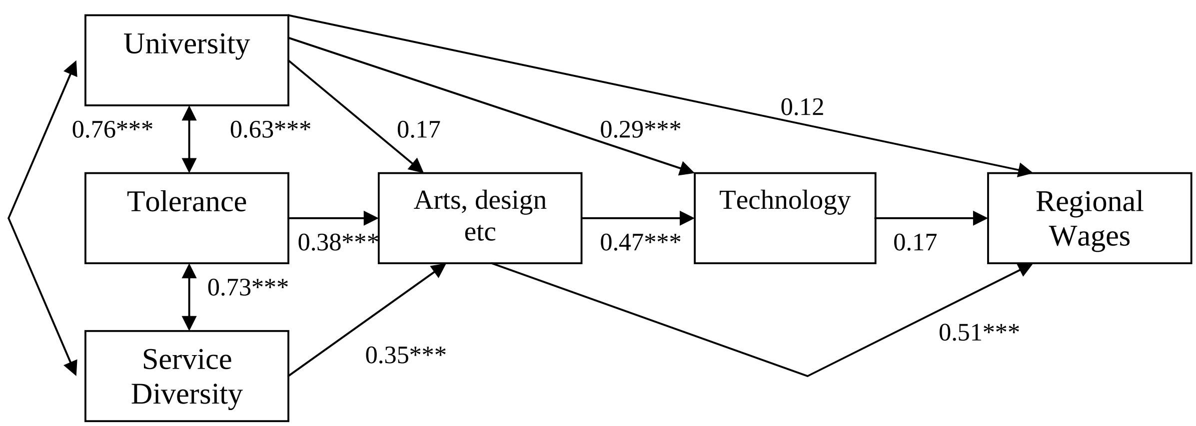


Figure 5e: Path analysis for arts/ design/ entertainment occupations

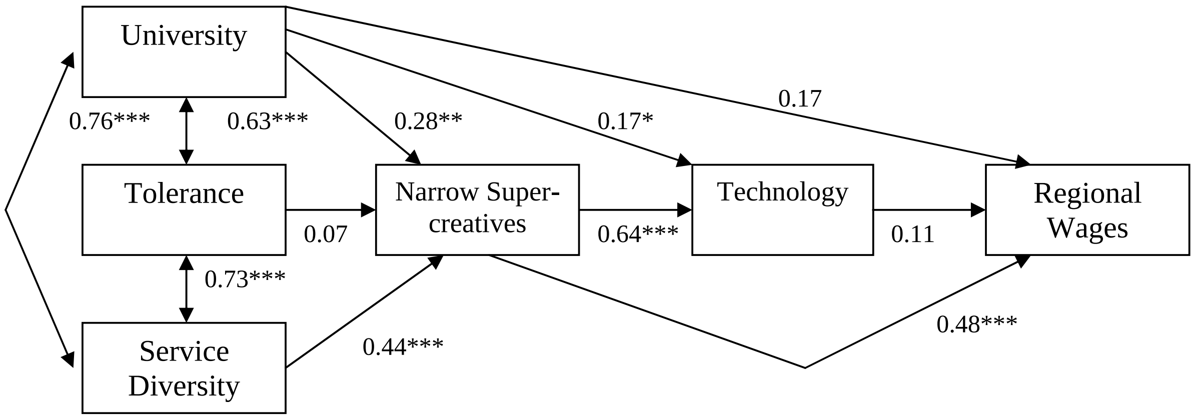


Figure 6: Path analysis for narrow super-creative core (without education-related occupations).

Tables and figures:

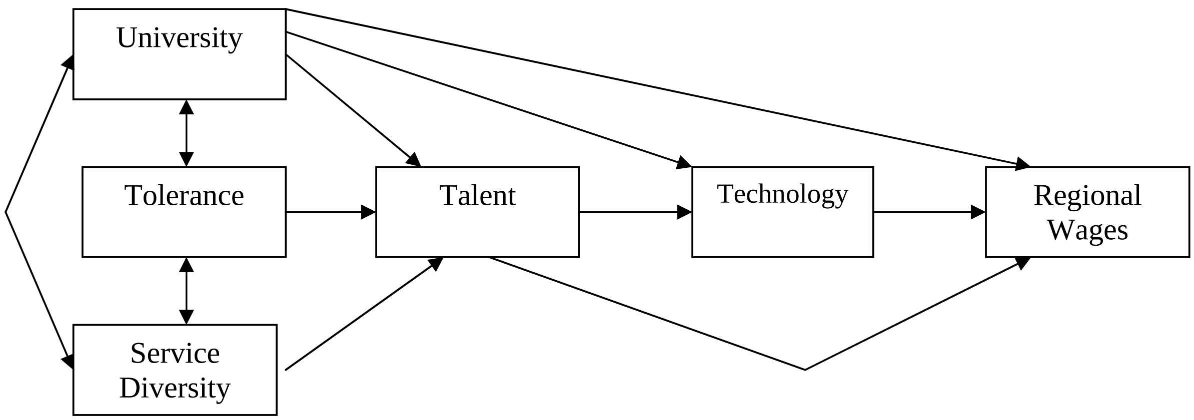


Figure 1: Model of key regional development paths

Table 1: Descriptive Statistics

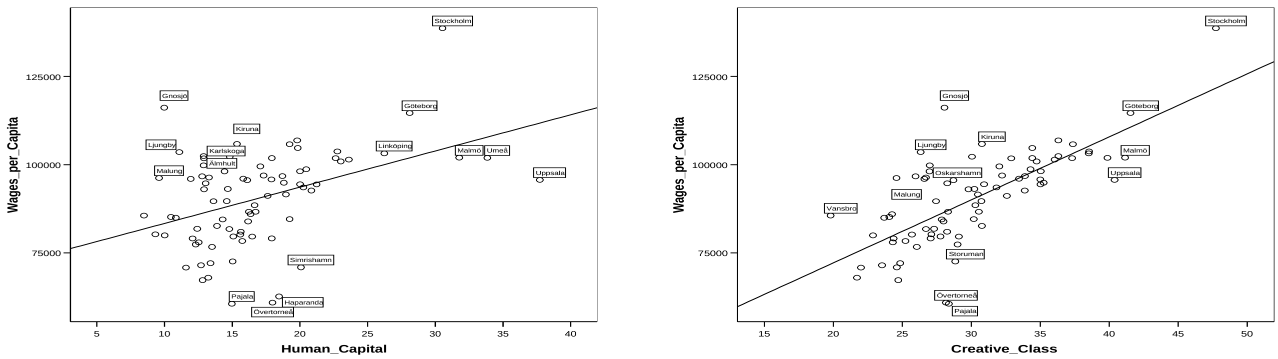
	Obs	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
University	81	0.31	0.465	0	1
Tolerance	81	2.4363	0.385	1.73	3.39
Service Diversity	81	159.14	48.936	56	259
Talent:					
BA or above	81	0.1682	0.055	0.08	0.38
Supercreative	81	0.1041	0.023	0.07	0.17
Creative Professionals	81	0.1976	0.035	0.13	0.31
Creative class	81	0.3018	0.053	0.20	0.48
Decomposed supercreative:					
Computer/ math	81	0.014	0.011	0.019	0.053
Arch/ engineering	81	0.007	0.006	0.000	0.029
Science	81	0.003	0.002	0.000	0.016
Education	81	0.073	0.011	0.057	0.119
Arts/ design/ media	81	0.007	0.004	0.002	0.023
Narrow super-creative class	81	0.031	0.019	0.006	0.105
Technology	81	0.621	0.256	0.023	1.67
Regional wages	81	90.351	13.391	60.606	138.635

Table 2: Regional distribution of key factors

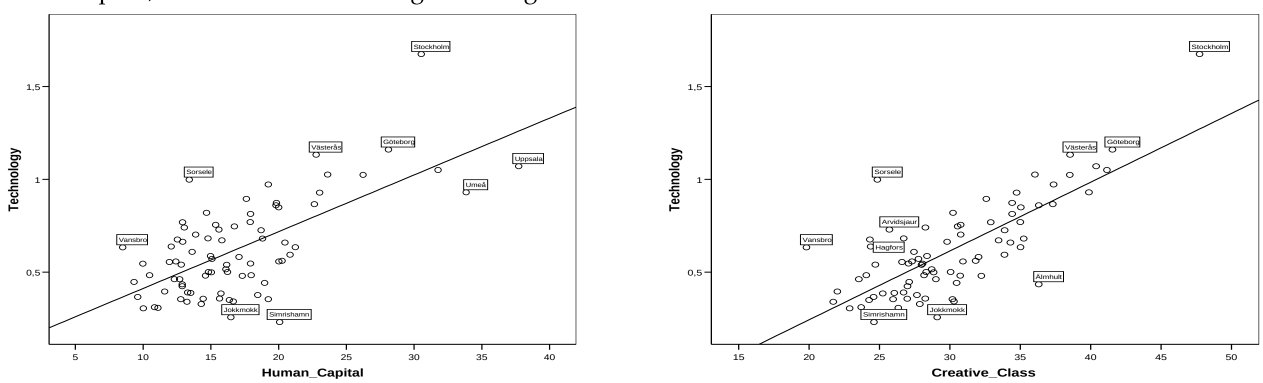
	Population	*Wages*	*Technology*	*Human Capital*	*Super-creative*	*Creative Class*
Stockholm	21.5	27.7	41.2	30.3	30.2	30.0
Gothenburg	10.3	11.0	11.7	12.5	11.8	11.6
Malmö	7.3	6.9	7.5	9.1	7.9	7.4
Helsingborg	3.4	2.9	2.1	2.7	2.5	2.7
Uppsala	3.2	2.8	3.1	4.6	3.6	3.1
Linköping	2.7	2.6	2.5	2.9	3.1	2.7
Örebro	2.5	2.2	1.5	2.1	2.1	2.2
Uddevalla	2.3	2.0	1	1.6	1.6	1.8
Skövde	2	1.7	1	1.3	1.4	1.5
Västerås	2	1.9	1.9	1.8	1.9	1.9
Sum	*57.2*	*61.7*	*73.5*	*68.8*	*66.1*	*64.9*
Σ Others (N=71)	42.8	38.3	26.5	31.2	33.9	35.1
Total	100	100	100	100	100	100

Table 3: Correlation matrix

	University	*Tolerance*	*Service Diversity*	*Human Capital*	*Creative Class*	*Super-creatives*	*Technology*	*Regional Wages/Cap*
University	1							
Tolerance	0.629**	1						
Service Diversity	0.760**	0.726**	1					
Human Capital	0.705**	0.637**	0.701**	1				
Creative Class	0.745**	0.649**	0.811**	0.822**	1			
Super-creative	0.674**	0.494**	0.615**	0.830**	0.880 **	1		
Technology	0.598**	0.464**	0.526**	0.655**	0.764**	0.721 **	1	
Regional Wages/Cap	0.551**	0.501**	0.730**	0.420**	0.703**	0.448**	0.574**	1



Human Capital, Creative Class and Regional Wages



Human Capital, Creative Class, and Technology

Figure 2: Human capital versus the creative class

Table 4: Conventional human capital

	Eq 1 - Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstand. B-coeff	Stand. B-coeff	Unstand. B-coeff	Stand B-coeff	Unstand. B-coeff	Stand. B-coeff
University	4.341*** (0.001)	0.37***	0.149** (0.019)	0.27**	11.272*** (0.002)	0.39***
Tolerance	2.991** (0.049)	0.21**				
Service Diversity	0.030** (0.036)	0.27**				
Talent			0.022*** (0.000)	0.46***	-0.337 (0.301)	-0.14
Technology					22.532*** (0.000)	0.43***
Observations	81		81		81	
R^2	0.581		0.466		0.405	

Table 5: The creative class

	Eq 1 – Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	3.273***	0.35***	0.036	0.07	1.653	0.06
	(0.003)		(0.549)		(0.629)	
Tolerance	1.097	0.10				
	(0.376)					
Service Diversity	0.058***	0.65***				
	(0.000)					
Talent			0.036***	0.66***	1.511***	0.54***
			(0.000)		(0.000)	
Technology					4.434	0.08
					(0.491)	
Observations	81		81		81	
R^2	0.699		0.586		0.499	

Table 6: Creative professionals

	Eq 1 - Talent		*Eq 2 – Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.918	0.12	0.122**	0.22**	0.096	0.00
	(0.188)		(0.043)		(0.973)	
Tolerance	0.965	0.11				
	(0.224)					
Service Diversity	0.047***	0.66***				
	(0.000)					
Talent			0.040***	0.54***	2.847***	0.73***
			(0.000)		(0.000)	
Technology					3.207	0.06
					(0.539)	
Observations	81		81		81	
R^2	0.713		0.508		0.610	

Table 7: Super-creative core

	Eq 1 – Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	2.356***	0.48***	0.113**	0.21**	10.568***	0.37***
	(0.000)		(0.045)		(0.002)	
Tolerance	0.132	0.02				
	(0.851)					
Service Diversity	0.011	0.23				
	(0.106)					
Talent			0.066***	0.58***	-0.671	-0.11
			(0.000)		(0.414)	
Technology					22.837***	0.44***
					(0.000)	
Observations	81		81		81	
R^2	0.479		0.542		0.402	

Table 8: Education-related occupations

	Eq 1 - Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages/Cap*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	1.209***	0.51***	0.324***	0.59***	11.922***	0.41***
	(0.002)		(0.000)		(0.000)	
Tolerance	-0.217	-0.08				
	(0.627)					
Service Diversity	-0.006	-0.28				
	(0.134)					
Talent			0.009	0.04	-5.024***	-0.41***
			(0.689)		(0.000)	
Technology					21.077	0.40
					(0.491)	
Observations	81		81		81	
R^2	0.109		0.358		0.557	

Table 9: Super-creative core without education

	Eq 1 - Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.011**	0.28**	0.096*	0.17*	4.799	0.17
	(0.017)		(0.069)		(0.128)	
Tolerance	0.003	0.07				
	(0.788)					
Service	0.000***	0.44***				
Diversity	(0.000)					
Talent			8.690***	0.64***	3.430***	0.48***
			(0.000)		(0.000)	
Technology					5.714	0.11
					(0.385)	
Observations	81		81		81	
R^2	0.537		0.588		0.481	

Table 10: Computer and math occupations

	Eq 1 – Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.661*	0.29*	0.235***	0.43***	8.741***	0.30***
	(0.061)		(0.000)		(0.005)	
Tolerance	-0.018	-0.01				
	(0.965)					
Service	0.005	0.23				
Diversity	(0.191)					
Talent			0.090***	0.38***	1.448	0.12
			(0.000)		(0.278)	
Technology					17.099***	0.33***
					(0.006)	
Observations	81		81		81	
R^2	0.229		0.469		0.406	

Table 11: Scientific occupations

	Eq 1 – Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.065	0.13	0.237***	0.43***	7.890**	0.27**
	(0.329)		(0.000)		(0.016)	
Tolerance	0.086	0.14				
	(0.259)					
Service	0.002***	0.44***				
Diversity	(0.003)					
Talent			0.330***	0.30***	8.088	0.14
			(0.003)		(0.193)	
Technology					17.485***	0.33***
					(0.003)	
Observations	81		81		81	
R^2	0.427		0.421		0.409	

Table 12: Engineering and architecture occupations

	Eq 1 - Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.268	0.19	0.160***	0.29***	5.321*	0.18*
	(0.123)		(0.002)		(0.073)	
Tolerance	-0.053	-0.03				
	(0.788)					
Service	0.007***	0.55***				
Diversity	(0.000)					
Talent			0.207***	0.52***	10.184***	0.49***
			(0.000)		(0.000)	
Technology					6.754	0.13
					(0.259)	
Observations	81		81		81	
R^2	0.477		0.529		0.508	

Table 13: Arts, design, and entertainment occupations

	Eq 1 - Talent		*Eq 2 - Technology*		*Eq 3 - Regional Wages*	
Variables	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff	Unstandard. B-coeff	Standard. B-coeff
University	0.131	0.17	0.161***	0.29***	3.468	0.12
	(0.114)		(0.006)		(0.262)	
Tolerance	0.303***	0.38***				
	(0.001)					
Service Diversity	0.003***	0.35***				
	(0.005)					
Talent			0.342***	0.47***	19.414***	0.51***
			(0.000)		(0.000)	
Technology					8.723	0.17
					(0.124)	
Observations	81		81		81	
R^2	0.602		0.484		0.516	

Appendix 1: Path illustrations:

Model 1: Human Capital (BA university degree or more)

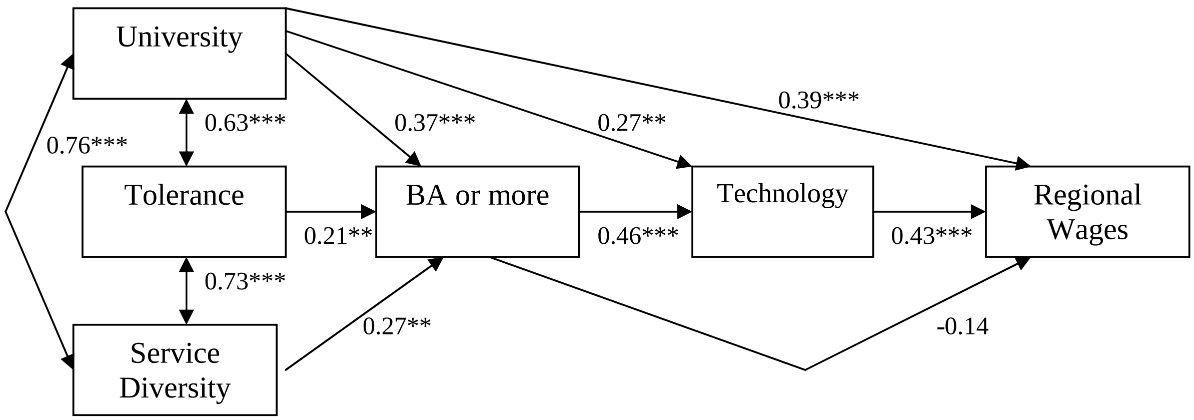


Figure 1: Path analysis for human capital

Model 2: Creative Class

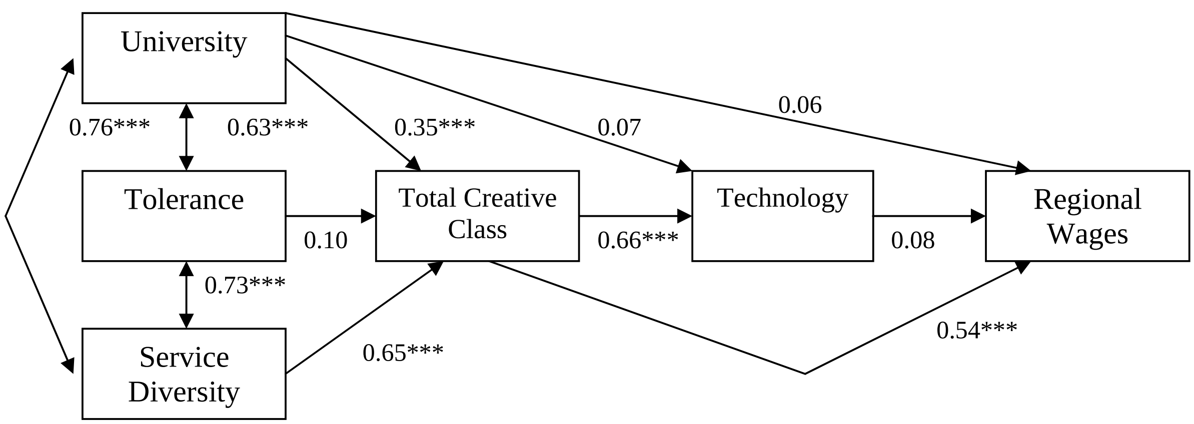


Figure 2: Path analysis for creative class

Model 3: Creative Professionals

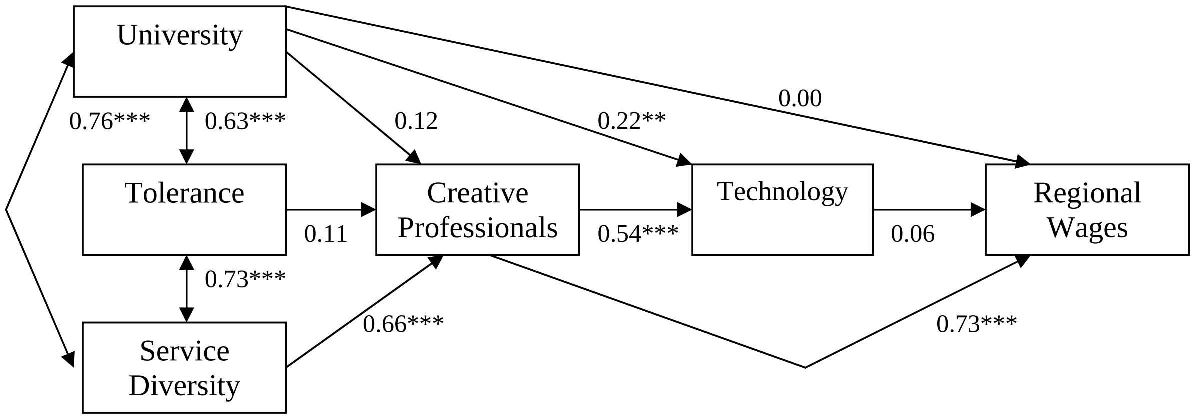


Figure 3: Path analysis for creative professionals

Model 4: Super-creatives

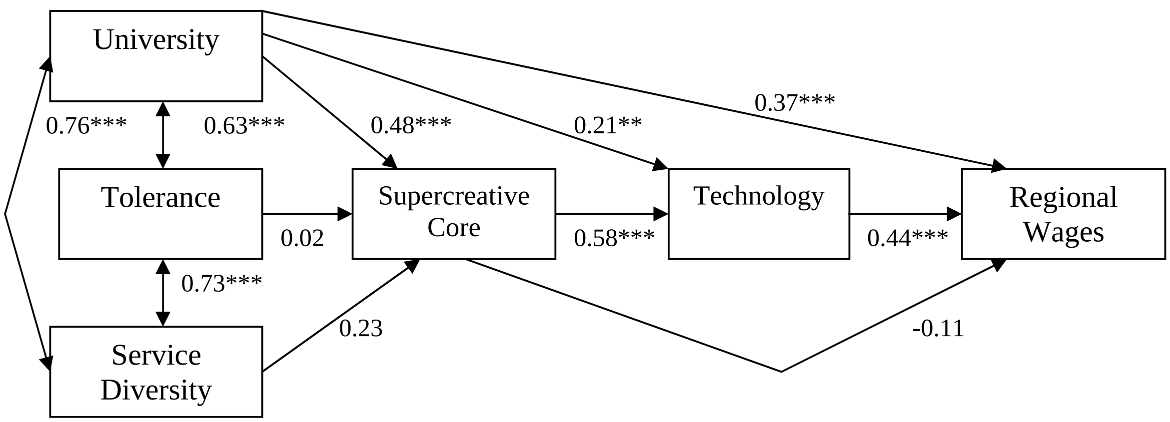


Figure 4: Path analysis for super-creative core

4.1. Decomposing the super-creative class:

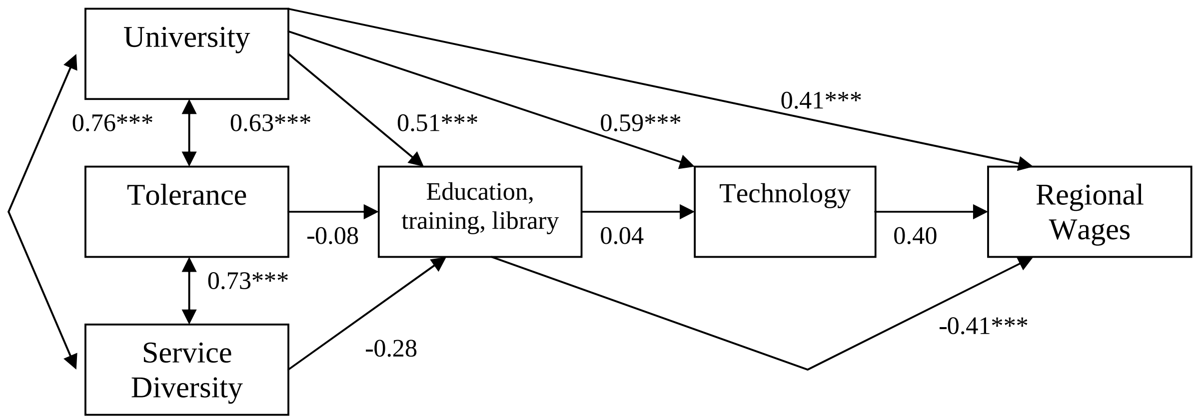


Figure 5a: Path analysis for education-related occupations

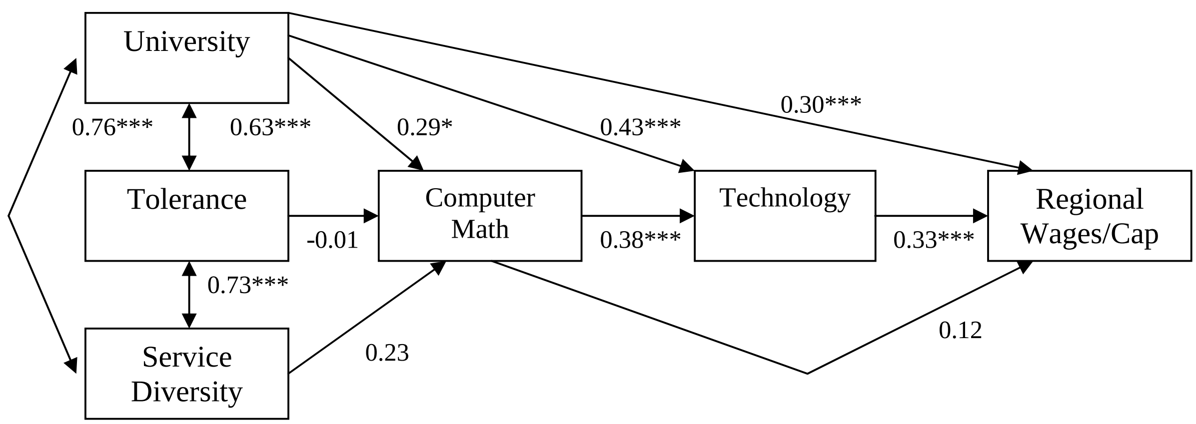


Figure 5b: Path analysis for computer and math occupations

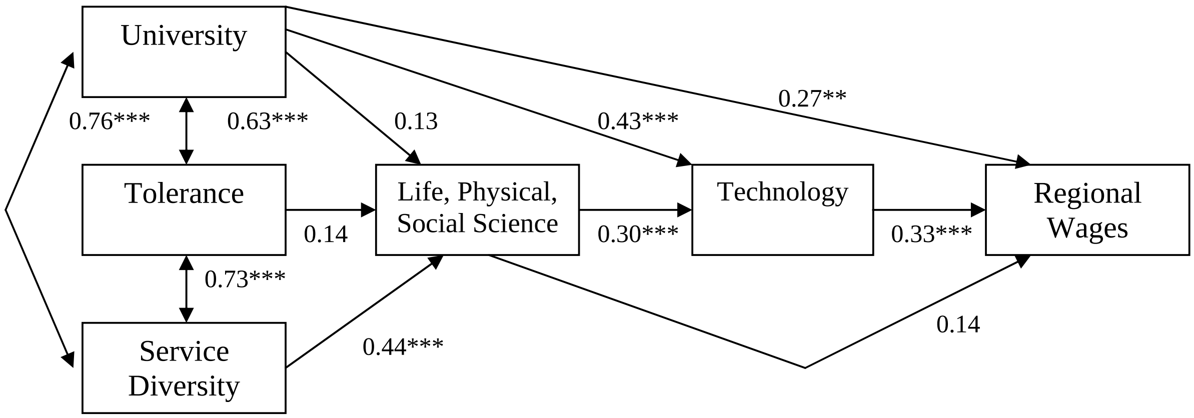


Figure 5c: Path analysis for life, physical and social science occupations

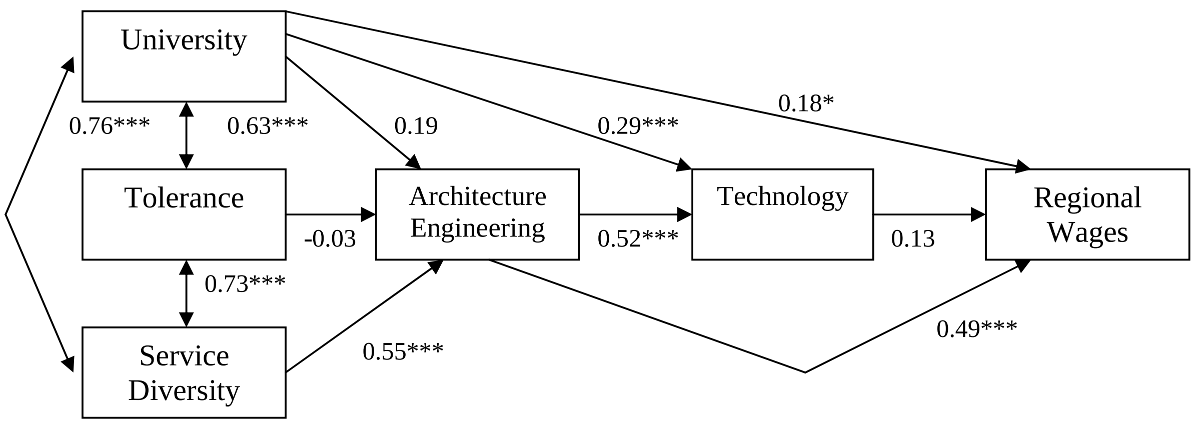


Figure 5d: Path analysis for architecture and engineering occupations

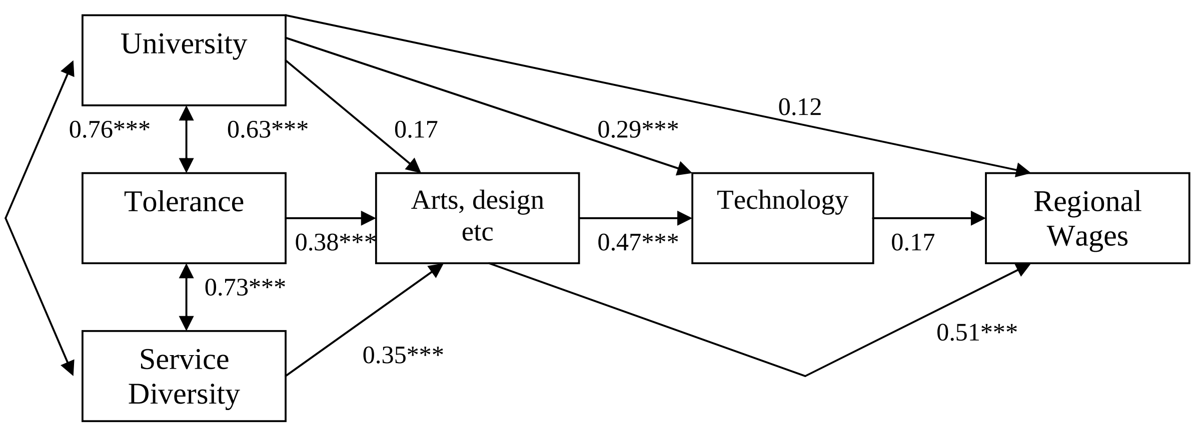


Figure 5e: Path analysis for arts/ design/ entertainment occupations

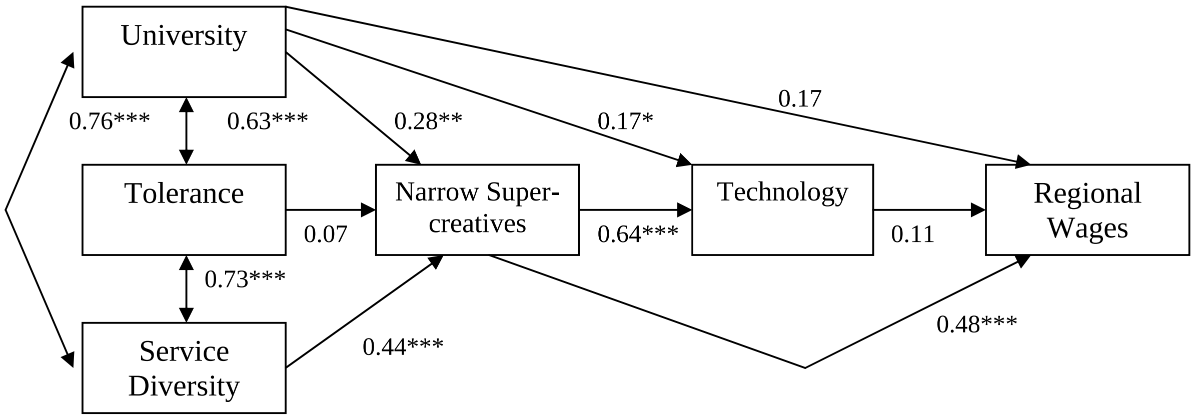


Figure 6: Path analysis for narrow super-creative core (without education-related occupations).