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CHAPTER 1 MACROECONOMIC PROCESSES AND REGIONAL ECONOMICS MANAGEMENT

Venture Capital Investment and Employment Growth¹

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Abstract: Labor market performance has differed considerably among OECD countries over the last two decades. The focus of the literature has so far been to ask whether these differences can be explained by varying degrees of labor market rigidities and generosity of welfare states. In this paper we analyze whether venture capital investments – both total and early stage venture capital investments – influences employment growth in a panel of 20 OECD countries. Our results suggest that labor market performance can be significantly affected by venture capital investments. The results are stronger for total venture capital as opposed to early stage venture capital, suggesting the possibility of a time-to-build effect.

Keywords: labor markets, venture capital, unemployment, new economy, panel data analysis

JEL classification: E22, E24, E44, G24, G32

I. Introduction

The persistent rise in unemployment along with the conspicuous lack of job creation in many continental European countries still begs to be thoroughly explained. Labor market rigidities along with generous welfare states are often considered to be at the root of the European unemployment problem⁵. While it seems by now well established that both factors do indeed matter considerably, it is far from clear that both factors even when taken together constitute a satisfactory explanation on their own. An obvious problem with this approach is the high degree of continuity of these institutions over time so that only a combination of these institutions with adverse shocks is a promising avenue for explaining simultaneously different labor market performances across countries and changes over time⁶. Furthermore, higher rates of job creation in Anglo-Saxon than in continental European countries have not been restricted to low-paid jobs, where labor market rigidities and the generosity of the welfare state matter most. It is far less evident why these institutional features should also obstruct the creation of medium and high paid jobs. Other structural factors, which impact clearly on the creation of all types of jobs, might therefore also be important.

Economic intuition suggests that job creation over the whole wage spectrum should not only be related to real wage costs and their flexibility in the face of shocks but also to economic growth and in particular to investments. A possible and hitherto under-explored structural factor in explaining labor market performance differences across countries and changes over time are there-

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⁵ See especially Siebert (1997).

⁶ See Berthold and Fehn (2002).

fore capital market institutions which might affect the ability of economies to invest, particularly in risky and new ventures¹. This type of investment appears to be crucial for job creation particularly in a period of radical structural change away from traditional industrial production toward the so-called new economy, in which new jobs are rarely created by the expansion of large and established firms.

A prime suspect in the realm of capital market institutions is the degree to which venture capital markets are well developed and flourishing. The US especially has benefited from a fully-fledged venture capital market whereas the German experiment with venture capital and the "Neuer Markt" seems to have been short-lived after the spectacular crash over the last two years. A number of studies document the ability of US venture capitalists to select promising companies, provide adequate financing and spur innovative firms to behave aggressively and emerge as market leaders². This helped the US to steam ahead in terms of competitiveness and growth during a time period when innovative change has been the cornerstone of entrepreneurial success.

Although venture capital financed investments relative to GDP are only a rough measure for the functioning of venture capital markets, this measure has the advantage of being available for a wide range of countries since the mid 1980s. Clearly, lack of venture capital financed investments is not necessarily only due to a lack of supply of venture capital as was for example suspected by the European Commission some time ago³, but can just as well be due to a lack of experienced venture capitalists or due to a demand problems possibly caused by a lack of innovative entrepreneurs asking for venture capital finance. Total measured venture capital investment obviously reflects both supply and demand for venture capital, and thus the overall functioning of the venture capital market.

It is not only the level of venture capital investments, but also the structure of such investments that may be important. So called "early stage investments" may be especially promising in this respect because they serve to set up a new firm with possibly new and innovative ideas. Management buy-outs where corporate insiders in established firms seek venture capital to take control of their firm appear to be less promising for creating positive employment effects in comparison. On the other hand however, there may be possible time-to-build effects, whereby it takes time until venture capital investments have realized their full employment potential. In this sense, expansion investment included in total venture capital may be the more important determinant of employment. Interestingly, early stage investments have until 1998 been much more prevalent in the US compared to continental Europe, where management buy-outs constitute a larger share of total venture capital investment. Hence, not only the total level of venture capital investments but also their structure appears to be less conducive to job creation in continental Europe compared to the US. This assessment is reinforced by the fact that banks and governments are major providers of venture capital in continental Europe, both of which are unlikely candidates for identifying the types of highly risky investments, which make most sense from a purely economic point of view. Finally, the two greatest shares of venture capital investments in continental Europe are devoted to manufacturing and to the consumer industry, whereas in the US venture capital investments are predominantly in the computer, telecommunications and biomedical industry. Hence, not only the level but also the structure of venture capital investments in the US appears to be more conducive to job creation from this sectoral perspective⁴.

Given the fact that European capital markets are traditionally bank-dominated⁵, it seems natural to ask why banks in Europe should not be able to play the role that venture capitalists are fulfilling in the US and other Anglo-Saxon countries. In other words, why do banks typically refrain from financing start-ups? In general banks are hardly suitable financiers for this type of risky

¹ Fazzari, Hubbard and Petersen (1998) and Hubbard (1998) show that financing constraints do indeed matter for corporate investments and that this is especially the case for risky and new ventures.

² See for example Hellmann and Puri (2000), Kortum and Lerner (1998) and Gompers and Lerner (2001).

³ See European Commission (1998).

⁴ See Bottazzi and Da Rin (2001).

⁵ See for example Edwards and Fischer (1994).

project. Raising deposits from the public at large usually finances bank lending and banks earn profits in this part of their business activities due to interest rate margins between credits and deposits. The generally high liquidity of deposits creates pressure on banks to engage predominantly in relatively liquid credit contracts. Hence, banks need debtor firms which are able to pay them back within a reasonably short time period and with a high probability and/or which can provide them with ample collateral (i.e. tangible assets such as property and buildings). These requirements can hardly be met by start-up firms, which are as a rule highly risky, have no positive cash flows for some time even in the case that they are fundamentally successful and which invest a large part of their acquired capital in intangible assets such as software and human capital which cannot serve well as collateral. Three additional reasons deserve to be mentioned why banks cannot act as perfect substitutes for US-style venture capitalists. First, the traditionally close ties between banks and established large industrial firms in a country such as Germany make banks less aggressive in nourishing possible future competitors of established firms. Second, due to the fact that the stability of the banking system is a politically sensitive issue, government regulations result in banks facing severe legal restrictions concerning the financing of risky investments such as start-ups. Third, banks hardly possess the sector- and firm-specific knowledge of US-style venture capitalists that is necessary to help young firms in managing the especially risky start-up and expansion phase.

In this paper we test the impact of both total and early-stage venture capital investments on employment for a sample of 20 OECD countries over the period 1986-1999. Our results indicate that venture capital can be an important determinant of employment in our sample of countries. The rest of the paper is organized as follows. Section II briefly discusses the theoretical background. Section III is the core of the paper as it presents new panel data empirical evidence for the OECD countries concerning the relationship between venture capital investment and employment performance at the macro level. Section IV offers policy conclusions.

II. Theoretical Background

Acemoglu (2001) has recently proposed a simple but highly plausible formal model in which differences in the ability of economies to channel external funds to new firms play a key role in explaining why some economies experience an extended phase of depressed job creation and persistent unemployment in the wake of the arrival of a new set of technologies and the accompanying structural change, while others adapt much faster to such a technological shock and largely avoid unemployment problems or lack of job creation¹. Better functioning venture capital markets in Anglo-Saxon countries in general and in the US in particular compared to continental Europe may reflect this difference in the ability to channel external funds quickly and smoothly to promising new entrepreneurs. Steady-state structural unemployment such as in the 1950s and 1960s need not differ much between the two types of economies if their labor markets work similarly well in such an institutional setting with different institutions on capital markets because entrepreneurs with promising and innovative ideas will eventually obtain funds possibly even through their own savings or via loans from the extended family.

In the medium run however, the failure of rigid capital markets with badly functioning venture capital markets to provide quick external financing to those entrepreneurs who are most promising after a technological shock leads to an extended phase of depressed job creation and a persistent rise in unemployment in the time following the change in the economic environment because job destruction in declining sectors cannot be prevented. Hence, unemployment is expected to rise persistently in the wake of a period of structural change and fall only gradually over time back to its pre-shock level with the emergence of new firms which is time-consuming due to a badly functioning market for external finance for new ventures. In contrast, no increase in unemployment is expected in an economy with perfect markets for the external finance of young and

¹ Two other important models with similar results, namely that credit market imperfections exacerbate structural unemployment caused by rigid labor markets, have been suggested by Caballero and Hammour (1999) and by Wasmer and Weil (2000).

risky ventures. According to this model, a direct effect of the functioning of venture capital markets on labor market performance can therefore be expected in a period of rapid structural change because employment creation depends on the creation of new firms in the fledgling and expanding sectors which can in turn only occur on a large scale and sufficiently quickly if adequate channels for financing such new and risky ventures, for example, via venture capital, are available. This fits well with an influential paper by Blanchard (1997) in which he labels structural unemployment in continental Europe as a medium run phenomenon in the aftermath of severe shocks. Interestingly, the malaise on the labor market is in some respect self-reinforcing in Acemoglu's model because higher unemployment in economies with rigid capital markets leads to lower real wages and thus also to lower savings of workers which prolongs the time until a worker with post-technology shock entrepreneurial ideas can start his own business based on his own savings.

However, it is important to keep in mind in this respect that structural unemployment can only exist if there is also at least some basic rigidity on the labor market. This result holds even under an institutional setting with malfunctioning capital markets because infinite real wage flexibility would always clear the labor market and wash out involuntary unemployment if labor markets were perfectly flexible no matter how small labor demand is due to financing restrictions. To avoid this problem, Acemoglu (2001) assumes an efficiency wage setup that prevents instantaneous labor market clearing via adjustments of real wages. While efficiency wage problems seem to have indeed become more important with the arrival of the new economy and with the ongoing reorganization of firms towards holistic instead of Tayloristic production structures¹, it appears that unions, insider-outsider problems and generous welfare states are still at least as critical in making continental European labor markets relatively rigid compared to the US for example². The combination of both, rigid labor markets and capital market institutions which do not fit well with a period of rapid structural change, can therefore be expected to be harmful to labor market performance because the quasi-equilibrium employment rate is then restricted from both sides, via more aggressive wage setting due to labor market rigidities and via depressed labor demand due to an obsolete institutional setting on the capital market. The quasi-equilibrium unemployment rate is higher, the less well the venture capital market works, given the level of labor market rigidities³.

Hence, venture capital cannot affect the unemployment rate under perfectly flexible labor markets because the labor market would always clear then. This caveat is only valid, though, when looking at the unemployment rate which would always be zero under perfect labor markets. A well-functioning market for external finance of firms and for venture capital may very well make a difference for spurring employment creation even under perfectly flexible labor markets because labor supply might react positively to improved earning possibilities. The effect is of course also not constant over time. Job creation might not depend much at all on the institutional setup of the capital market in relatively stable times, when there is little structural change and the importance of developing innovative products and of setting up new firms in fledgling sectors is small, one example being Germany or Japan in the post-war period until the late 1970s.

In the following section we look for evidence of a relationship between imperfect capital markets and labor market performance, which to date is still lacking in this fledgling literature⁴. The hypothesis for our empirical analysis is straightforward. It is conjectured that greater venture capital investments relative to GDP give rise to more employment in a cross-country panel analysis for the 1980s and 1990s when structural change has indeed been rapid not least due to globalization.

¹ See Lindbeck and Snower (2000).

² See Berthold and Fehn (2002).

³ See Fehn (2002).

⁴ See Caballero and Hammour (1999), Wasmer and Weil (2000) & Acemoglu (2001).

III. Empirical Estimation

1. Model and Estimation Procedure

In this section we estimate the impact of both total and early stage venture capital investments on employment growth for a sample of 20 OECD countries in the period 1986-1999¹. Data descriptions and sources are provided in Table 1. We choose to concentrate our analysis on employment as we expect that a well-functioning venture capital market is more conducive to job creation in new and innovative firms and in integrating young people quickly into the regular labor market, rather than in helping preserve jobs in old in declining industries. As such we expect venture capital investments to have a more significant impact on employment than on official unemployment.

Table 1

Description of the labor market and capital market variables

Macroeconomic time series	
Total employment (EMP)	Civilian or (if not available) total economy employment (employees and self employed, index with base year 1995). Source: OECD Main Economic Indicators.
Real gross domestic product (GDP)	Source: OECD Main Economic Indicators
<i>Institutional labor market variables</i>	
Benefit replacement ratio (RR1)	Average replacement rate over the first year of an unemployment spell. Source: Blanchard and Wolfers (1999), pp. 11 ff. and data appendix. Three realizations per country (for 1986-89, 1990-94 and 1995-99). Indicator displays more variability than RRATE.
Benefit duration (BENEFIT)	Duration of unemployment benefits (years, 4 years meaning indefinite). Source: Layard and Nickell (1997), pp. 11 ff., and complementary data delivered by S. Nickell.
Union coordination index (UNCORD)	Union co-ordination in wage bargaining. Index with 3 = high, 2 = middle, 1 = low. Source: Layard and Nickell (1997), Table 3, and complementary data delivered by S. Nickell.
Union coverage index (UNION)	Index, 3 = over 70% covered, 2 = 25-70% covered, 3 = under 25% covered. Source: Layard and Nickell (1997), Table 3, and complementary data delivered by S. Nickell.
<i>Employment protection index (EMPRO)</i>	Country ranking with 20 as the most strictly regulated. Source: Layard and Nickell (1997), p. 6, Table 2, and complementary data delivered by S. Nickell.
<i>Tax wedge (WEDGE)</i>	Total tax wedge (in %). Sum of the payroll tax rate, the income tax rate and the consumption tax rate. Average rates derived from national income and tax data. Source: Layard and Nickell (1997), p.4, Table 1, and complementary data delivered by S. Nickell.
<i>Venture capital investment time series</i>	
Venture capital investment (VC)	Seed, startup and expansion (both government and private sector funded) as per mil of average GDP. Source: Own calculations based on Asian Venture Capital Journal (2000), Baygan, Freudenberg (2000), European Venture Capital Association (2000), National Venture Capital Association (2000), Jeng, Wells (2000)

¹ The 20 countries being: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, Canada, United States of America, Japan, Australia and New Zealand.

Table 1 (continuous)

Early stage venture capital investment (INVEARLY)	Seed and startup (both government and private sector funded) as per mil of average GDP. Source: Own calculations based on Asian Venture Capital Journal (2000), Baygan, Freudenberg (2000), European Venture Capital Association (2000), National Venture Capital Association (2000), Jeng, Wells (2000)
<i>Institutional capital market variables</i>	
Creditor rights (CREDITRIGHT)	Index of the legal system's protection of creditors in case of a firm's liquidation or reorganization. Range: 0 to 4, 4 is the highest level of creditor protection. Source: La Porta et al. (1998), p. 1136, Table 4.

The basic model which we wish to estimate is the following:

$$\ln EMP_{it} = \alpha + \beta_1 VC_{it} + \beta_2 \ln GDP_{it} + \delta_j X_{jit} + \varepsilon_{it}, \quad (1)$$

where EMP is an index of employment for country i in period t , VC_{it} is our measure of venture capital for country i in period t , GDP is the level of real gross domestic product for country i in period t , included as a cyclical control variable following Wasmer and Weil (2000) and X_{jit} is a vector of j additional variables used to control for key institutional variables.

The above model is static in nature, not taking into account the dynamics of employment. As such there are reasons to believe that such a model may be dynamically mis-specified, which we account for with the following equation:

$$\ln EMP_{it} = \alpha + \gamma \ln EMP_{t-1} + \beta_1 VC_{it} + \beta_2 \ln GDP_{it} + \delta_j X_{jit} + \varepsilon_{it}, \quad (2)$$

where EMP_{t-1} are lags of the dependent variable. This has the appeal that it models employment in a dynamic context, which allows venture capital to have both a short-run and a long-run impact on employment.

Dynamic panel models are characterized by the presence of a lagged dependent variable. Introducing a lagged dependent variable as an explanatory variable does mean that it and the error term are correlated rendering standard estimators of panel data biased. One solution to this problem is to first difference the model and to use lags of the dependent variable as instruments for the lagged dependent variable. Our solution is to use the GMM approach of Arellano and Bond (1991). This makes use of the fact that values of the dependent variable lagged two periods or more are valid instruments for the dependent variable. This will generate consistent and efficient estimates of the parameters of interest¹.

Given the above discussion and considering similar specification for both the static and dynamic models, gives the following final estimating equations:

$$D \ln EMP_{it} = \beta_1 DVC_{it} + \beta_2 DGDP_{it} + \delta_j X_{jit} + \Delta \varepsilon_{it}, \quad (3)$$

and

$$D \ln EMP_{it} = \gamma \Delta \ln EMP_{t-1} + \beta_1 DVC_{it} + \beta_2 DGDP_{it} + \delta_j X_{jit} + \Delta \varepsilon_{it}, \quad (4)$$

¹ Consistency of the GMM estimator requires a lack of second order serial correlation in the dynamic formulation, so tests for this are presented with the results. Overall instrument validity is also examined using a Sargan test of over-identifying restrictions.

where D refers to the first difference of the variable in question¹. The model we estimate therefore examines the impact on the (approximate) growth of employment of the change in venture capital², the change in GDP and of additional labor market institution variables. One thing to note from these equations however is that the additional variables accounting for institutional variables are included in levels rather than differences, these are included in levels since they show little variation across time.

We sequentially use two measures of venture capital, these being either the change in venture capital (DVC) or the change in early stage venture capital ($DINVEARLY$). DVC is defined as the seed, start-up and expansion (both government and private sector funded) as per million of average GDP, while $DINVEARLY$ is used to account for early stage venture capital only, and is defined as the seed and start-up (both government and private sector funded) as per million of average GDP. There is good reason to believe that these variables measuring venture capital may be endogenous. This is not only valid with respect to the labor market variables but also to another independent variable, namely real GDP that is used as a cyclical control variable in our model. Hence, in the case of a significant coefficient on venture capital, one could argue that the demand for finance has been strong and the supply of venture capital has been stimulated in those countries that have been innovative and able to create jobs (strong employment growth) and where the macroeconomic climate has been favorable and macroeconomic policy has been supportive³. In this case, both employment and venture capital investment may then be driven by a third factor. To account for the problem of endogeneity of the venture capital variable and thus for possible reverse causality we instrument the venture capital variables, employing the second lag of the venture capital variables as instruments.

The additional variables in the model are included to control key institutional characteristics. Firstly, we include variables to control various institutional labor market variables. As such, we include a measure of the benefit replacement ratio (RRI), a measure of the duration of unemployment benefits ($Benefit$), a measure of employment protection ($Empro$), the tax wedge ($Wedge$), the union coverage index ($Union$) and a measure of the centralization of wage bargaining ($Uncord$). These are expected to adequately control the factors that contribute towards labor market rigidities, which include high firing costs, strong unions and generous employment benefits. Secondly, we include a variable to account for the presence of institutional capital markets, by including an index of the legal system's protection of creditors in case of a firm's liquidation or reorganization ($CreditRight$). This variable reflects the legal position of creditors' vis-à-vis firms in case of financial distress.

With respect to the sign on the coefficients of these additional variables included in our regressions, we expect the following marginal coefficients for the employment equations.⁴ We expect RRI , $Benefit$, $Empro$, $Wedge$ and $Union$ to be negative, while the coefficients on $Uncord$ and $CreditRight$ are expected to exert a positive impact on employment. At the same time we expect that the coefficients on the changes in the two venture capital variables (DVC and $DINVEARLY$) would be positive so that more venture capital investment would raise employment growth.

¹ Differencing the data has a further advantage in this setting. Levin and Lin (1992) tests of the stationarity of our variables of interest suggest the possibility that the levels of a number of our variables are non-stationary, while their differences are not. As such, using a method that differences the data avoids the possibility of spurious results. Results of the stationarity tests are available from the authors on request.

² We also included in various specifications the change in the log of venture capital. This resulted in positive coefficients, but the results were not as strong, in that the coefficients were not always significant. Similarly, we also included in various specifications GDP growth (i.e. the change in the log of GDP) as opposed to simply the change in GDP. This didn't affect the results a great deal, though in a small number of cases GDP growth was not significant where the change in GDP was. These results are available on request.

³ Given that labor market institutions are often badly measured, an alternative view would be that venture capital may capture their effects.

⁴ See for example, Blanchard and Wolfers (1999), and Layard and Nickell (1997).

2. Results

Based on the above arguments, we conjecture that controlling the key institutional variables on the labor and the capital market, the presence of venture capital improves employment performance in a cross-country panel analysis. The following tables display the results from estimating equations 3 and 4. Tables 2 and 3 report the coefficients along with the heteroscedastic consistent t-ratios.

Table 2

Total venture capital investment and employment growth

DlnEMP	1	2	3	4	5	6
DlnEMP-1				0.51 (9.08)***	0.41 (5.81)***	0.43 (6.02)***
DVC	0.03 (1.95)**	0.03 (1.75)*	0.03 (0.94)	0.009 (3.37)***	0.008 (2.6)***	0.006 (1.87)*
DGDP		0.005 (1.41)**	0.005 (1.64)*		0.005 (6.39)***	0.006 (5.1)***
RR1			-0.0009 (-0.7)			0.0001 (0.51)
Benefit			0.003 (0.32)			-0.0002 (-0.11)
Uncord			0.03 (1.14)			0.005 (0.79)
Empro			0.002 (0.46)			0.001 (2.03)**
Wedge			-0.0001 (-0.11)			-0.0001 (-0.23)
Credit Right			-0.01 (-0.67)			0.003 (1.11)
Union			-0.03 (-0.61)			-0.02 (-1.53)
Constant	0.005 (1.44)	-0.006 (-0.83)	0.07 (0.71)	0.003 (2.98)***	-0.007 (-4.26)***	0.002 (0.13)
Wald Test	3.79*	8.24**	14.24	139.8***	118.2***	298.3***
Sargan Test	0.45 (df = 10) (p = 0.45)	6.92 (df = 9) (p = 0.65)	0.94 (df=2) (p = 0.63)	96.5** (df=75) (p = 0.048)	79.62 (df=74) (p = 0.31)	56.8 (df=67) (p = 0.81)
1 st Order Correlation	2.46**	2.04**	1.4	0.66	-1.05	0.11
2 nd Order Correlation	2.09**	1.61	1.13	-0.3	-0.38	1.05

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively. For the Sargan test, we report the test statistic alongside the number of degrees of freedom (df) and the p-value. The instruments used in the static model are the lags of the change in venture capital, while

in the dynamic model we have the lags of the change in venture capital and the lags of the lagged dependent variable as instruments.

Table 3

Early stage venture capital investment and employment growth

DlnEMP	1	2	3	4	5	6
DlnEMP-1				0.51 (11.04)***	0.41 (5.16)***	0.41 (4.73)***
DINVEARLY	0.01 (0.59)	0.04 (1.91*)	-0.02 (-0.27)	0.02 (2.44)**	0.02 (1.92)*	0.01 (1.51)
DGDP		0.007 (3.44)***	0.01 (1.46)		0.005 (7.69)***	0.006 (5.87)***
RR1			-0.0008 (-0.48)			0.00004 (0.2)
Benefit			0.007 (0.54)			0.0002 (0.1)
Uncord			-0.01 (-0.63)			0.006 (0.83)
Empro			-0.001 (-0.36)			0.001 (1.82)*
Wedge			0.002 (0.78)			-0.00003 (-0.12)
Credit Right			-0.00002 (-0.0008)			0.005 (1.05)
Union			-0.01 (-0.21)			-0.02 (-1.67)*
Constant	0.008 (3.28)***	-0.01 (-1.9)*	-0.03 (-0.21)	0.003 (3.02)***	-0.007 (-3.67)***	0.004 (0.18)
Wald Test	0.35	11.91***	33.74***	232.08***	87.4***	264.47***
Sargan Test	16.21* (df=10) (p = 0.09)	13.26 (df=9) (p = 0.15)	1.11 (df=2) (p = 0.58)	100.08** (df=75) (p = 0.03)	84.68 (df=74) (p = 0.19)	51.83 (df=67) (p = 0.91)
1 st Order Correlation	2.61***	1.78*	1.35	0.68	-0.97	0.94
2 nd Order Correlation	2.15**	0.66	1.21	-1.06	-0.65	1.25

Note: All models are estimated using robust standard errors. Values in parentheses are t-statistics. ***, **, * indicate significance at the 1, 5 and 10 percent levels respectively. For the Sargan test, we report the test statistic alongside the number of degrees of freedom (df) and the p-value. The instruments used in the static model are the lags of the change in venture capital, while in the dynamic model we have the lags of the change in venture capital and the lags of the lagged dependent variable as instruments.

To begin the discussion of our results, note that the Sargan test for the validity of the instruments is insignificant in the dynamic model, except in one case, and that the test of second order serial correlation is insignificant in the dynamic model, suggesting that the model in general is well specified.

Turning to the coefficients on the additional variables in our model, we see that the coefficient on the change in GDP is positive as expected, and tends to be significant in both tables and in both the static and dynamic specification. The coefficients on the institutional variables included in the models tend to be very small however and in only a small number of cases are they significant. Employment protection is significant in both dynamic specifications but with a positive sign, which is against what we expected. However, the impact of employment protection on labor market performance is highly disputed in theory so that our expectations were only bordered in this case. The union coverage index is significant and negative as expected in the dynamic case of Table 3.

These weak results on the institutional variables are likely to reflect a number of concerns with the data on these institutional variables. Firstly, we may expect a great deal of multicollinearity between these variables and the results are indicative of such a problem, characterized by insignificant coefficients and coefficients that are not of the expected sign. Table 4 reports the correlation matrix and we can see from this that the correlations between amounts of the institutional variables are reasonably high. This is in contrast to the correlation coefficient between the change in VC investment and real GDP growth, which are low (0.1 for both *DVC* and *DINVEARLY*). Secondly, the lack of consistent and significant results on these additional variables may reflect the fact that they show little, if any, variation over time. These data have been used to explain labor market performance in cross-section and panel data studies using averages over time and have been found to be significant¹. Given that our data has a significant time-series dimension to it, we would expect that the coefficients on these variables would not be as significant as in a cross-section regression for example, where only the cross-country and not the time-series variation would be important. Although these problems are likely to be important, it needs to be kept in mind that these are not the variables of primary interest in this paper and that they are included largely as a test of robustness on the variable of interest here, namely venture capital.

Finally, we turn to the variables representing venture capital. Table 2 examines the impact of the change in venture capital on the growth of employment. The coefficients on *DVC* are always positive as expected, and they are also significant at least at the 10 percent level in five out of the six cases depicted. The dynamic results tend to be more supportive of a significant impact of *DVC* on the growth of employment, in the sense that the coefficients tend to be significant at higher levels of significance. At the same time, the coefficients in the static model tend to be larger in absolute value.

Table 3 replaces *DVC* with *DINVEARLY*, in order to examine the impact of early stage venture capital investment on employment growth. The coefficients on *DINVEARLY* are not as supportive of an impact of early stage venture capital investment on employment growth possibly reflecting the fact that expansion investment which is not included here affects job creation most directly. Although the coefficient is positive as expected in five out of six cases, it is now significant in only half of the cases. Once again, the results are more supportive in the dynamic case, with more significant coefficients being found, which indicates once again that the employment effects of venture capital investment are part of a dynamic process.

¹ See for example, Nickell (1997) and Nickell and Layard (1999).

Table 4

Correlation Matrix

	DEMP	DlnEMP	DGDP	DlnGDP	Dlnvearly	DlnInvearly	DVC	DlnVC	RR1	Benefit	Uncord	Empro	Wedge	Credit	Union
DEMP	1														
DlnEMP	0.99	1													
DGDP	0.52	0.51	1												
DlnGDP	0.47	0.47	0.98	1											
Dlnvearly	0.15	0.14	0.1	0.05	1										
DlnInvearly	0.10	0.1	0.09	0.07	0.5	1									
DVC	0.16	0.16	0.1	0.07	0.77	0.34	1								
DlnVC	0.1	0.1	0.13	0.13	0.33	0.51	0.62	1							
RR1	-0.07	-0.07	-0.06	-0.05	-0.006	-0.007	-0.005	-0.04	1						
Benefit	0.14	0.14	0.17	0.18	-0.08	0.03	-0.07	-0.04	-0.2	1					
Uncord	-0.17	-0.17	-0.05	-0.05	-0.12	0.01	-0.08	0.02	0.35	-0.02					
Empro	-0.13	-0.14	0.03	0.05	-0.12	-0.008	-0.1	0.01	0.11	0.18	0.37				
Wedge	-0.26	-0.16	-0.13	-0.12	-0.001	0.04	0.01	0.02	0.35	-0.12	0.51	0.45			
Credit	-0.03	-0.03	-0.06	-0.05	-0.11	-0.02	-0.05	0.01	-0.3	0.34	0.51	0.05	-0.004		
Union	-0.07	-0.08	0.12	0.13	-0.16	-0.02	-0.14	-0.01	0.34	0.37	0.63	0.7	0.43	0.1	

In sum, our results produce evidence in favor of our central hypothesis, namely that venture capital investment does improve employment performance. Our results suggest that the positive impact of venture capital investment on employment growth is more dynamic than static in nature possibly due to a time-to-build period, i.e. it takes time until venture capital investments have realized their full employment potential via feed-back and trickle down effects on other firms. These other non-venture capital backed firms might benefit, for example as suppliers or customers from the venture-capital backed firms or as they improve their products or production processes based on new ideas of the usually more innovative venture capital backed firms¹. The results obtained are stronger for the change in total venture capital investments as opposed to the change in early venture capital investment. We suspect that the weaker results on *DINVEARLY* may be due to a combination of a time-to-build effect, which favors the inclusion of expansion investment in the estimations, and labor supply moving in parallel to the overall economic development and thus also venture capital investments.

3. Long-run effects

Based on our dynamic results, one can estimate the long-run contribution of venture capital on employment growth, using the formula $\sum \beta_i / (1 - \sum \alpha_i)$, where β_i are the coefficients on the venture capital variables and α_i are the coefficients on the lagged dependent variable. The long-run effect of venture capital for the results displayed in Tables 2-3 is reported in Table 5.

Table 5

Long Run Impact of Venture Capital Investment on Employment Growth

	Column 4	Column 5	Column 6
Table 2	0.018	0.014	0.011
Table 3	0.041	0.03	0.017

To understand what these results imply we can use an example. If we take the value 0.018 from the table, this tells us that a one unit increase in venture capital (i.e. $DVC = 1$) will increase employment growth by 1.8 percentage points. Taking the example of Germany, which had an average change in VC investment over the period studied of $DVC = 0.15$ units and a change in early VC investment of $DINVEARLY = 0.04$ units, we can calculate that a one standard deviation increase in the change in DVC (coincidentally equal to 1.00) would have increased employment growth by around 1.8 percent according to the value 1.8.² Moreover, the value of 0.041 in Table 6 would imply that a one standard deviation increase in $DINVEARLY$ (equal to 0.25) would have raised employment growth by around 1 percentage point. We can conduct similar exercises for the remaining entries in Table 6. Doing so suggests that an increase in DVC by one standard deviation would increase employment growth by between 1.1 and 1.4 percent. Similarly an increase in $DINVEARLY$ by one standard deviation would increase the change in employment by between 0.43 and 0.75 percent. It should be noted that these figures are strikingly similar for DVC and $DINVEARLY$. One note of caution in interpreting these figures is that we are using at most 13 years of data to try and infer the long-run impact of venture capital on employment growth.

The non-negligible size of these effects must be attributed to our conjecture that venture capital investment is different from standard types of investment because it is directed especially to new and innovative firms. If projects which are funded via venture capital turn out to be successful, they therefore tend to have particularly large returns on investment and they also tend to

¹ See Kortum and Lerner (1998).

² The high empirical realization of the standard deviation is due to the explosive development of the venture capital investment time series. The latter became obvious already in the panel unit root tests by the high positive numbers of the ADF-test statistics for the levels of these variables (see Tables 2a and 2b).

have particularly large multiplier effects on output and employment, for example, by encouraging technological advancements or by generating a market for a new innovative product. The total real effect of successful venture capital investment is therefore not at all restricted to the firm directly concerned, but spill-over and trickle-down effects to other firms also matter.

IV. Conclusions

Many economists argue that labor market rigidities and generous welfare states are at the core of persistently low job creation in continental Europe compared to most Anglo-Saxon countries and especially compared to the US in the nineties. However, it is important to note that job creation might in addition depend on markets which are complementary to the labor market and whose malfunctioning might also constitute a bottleneck for job creation. Such a bottleneck might be the possibility for young and innovative firms to obtain finance for their highly risky projects. Hence, by leaving out capital market variables, past empirical results might have missed other important institutional factors and might have overstated the impact and significance of some of the labor market variables due to an omitted variable bias. The ability of a country to encourage and sustain technological innovation by entrepreneurial firms is after all one of the main sources of economic and employment growth.

Economic intuition suggests that venture capitalists have to play a key role in this respect because they have often been able to provide promising companies with adequate risk financing, this especially being the case in the US. Economists have so far paid relatively little attention to the possibility of a virtuous circle between entrepreneurial dynamism, innovative start ups, a dynamic venture capital industry and job creation.

Two of the leading researchers on venture capital, Paul Gompers and Josh Lerner, have recently argued that it is a challenging empirical problem to demonstrate a causal relationship between the presence of venture capital investment and innovation or job growth¹. This paper produces empirical evidence of such a link at the macroeconomic level. We are able to show that venture capital investment is able to significantly raise employment growth. We conjecture that venture capital is mainly conducive to job creation in new and innovative firms and that it facilitates the process of structural change toward the new economy. This is of little help, though, in reintegrating the long-term unemployed into the regular labor market where appropriate reforms of the welfare state and of labor market institutions have to play the key role.

The results obtained are of particular importance considering the fact that direct policies to combat unemployment, for example, by deregulating the labor market or by trimming welfare state activities, are notoriously difficult to implement in the political decision process, so that indirect alternative routes such as via fostering the venture capital market and thus entrepreneurial dynamism are urgently called for in continental Europe.

These results however, should not be misinterpreted as a justification for government subsidies to the venture capital industry or for government-run venture capital activities. Rather, the government should provide an institutional framework which is favorable to the development of a flourishing private venture capital industry and entrepreneurial dynamism. There exist a number of possible ways of doing so. First, the pension system could be capitalized to a greater extent and pension funds could be allowed to invest part of their assets in venture capital firms. Based on the US example, this should further spur the development of the venture capital market in continental Europe.² Second, a well-functioning market for initial public offerings such as NASDAQ needs to be created as an exit route for venture capitalists. This is especially important since European attempts at doing so such as the "Neuer Markt" have recently crashed spectacularly. Trust and transparency are clearly key issues in recreating such an exit market so that there is especially a need for strong and unequivocal corporate governance and accounting rules.

¹ See Gompers and Lerner (2001, p. 164).

² See Jeng and Wells (2000).

However, it is also important to keep in mind in this respect that it is not only the supply of venture capital which might restrict the total volume of venture capital investment, but possibly also the lack of suitable entrepreneurs with innovative ideas as well as the lack of incentives to undertake risky ventures and to disclose innovative ideas to possible financiers. With respect to this last point, third possible policy to foster venture capital markets is therefore the implementation of stronger patent rights along the lines of the US. This might be conducive to fostering venture capital markets because innovative entrepreneurs might then be less afraid to disclose their ideas to a venture capitalist who might possibly embezzle them.

Fourth, the education system especially at the university level along with an elaborate institutional framework for transforming innovative ideas into new business ventures would be the primary levers to address such a scarcity of able human resources. Fifth, the tax system should provide adequate incentives for risk-taking of entrepreneurs rather than having the government only participate strongly via highly progressive taxes in the upside of ventures. A highly progressive tax system, high taxation of capital gains, taxes on assets of firms along with strict limitations to rolling over losses, which are almost inevitable in the start-up phase of new ventures, into future periods are important factors stifling entrepreneurial dynamism and venture capital investments.

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