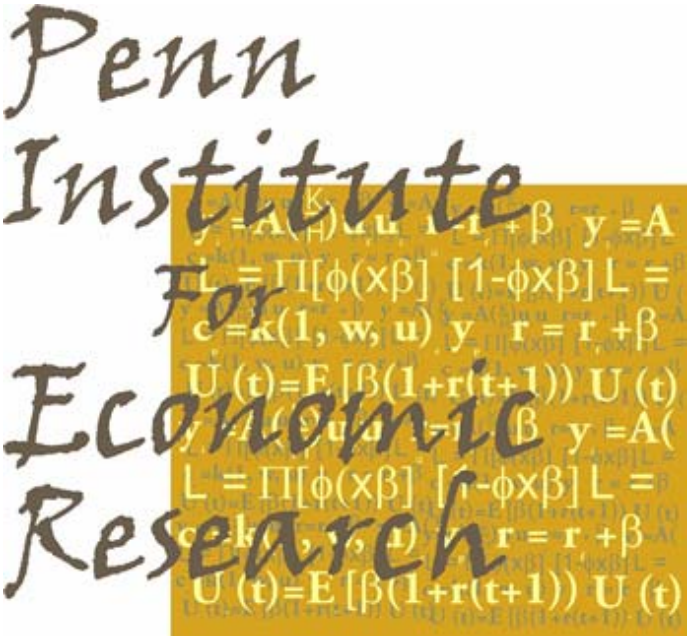


Penn Institute for Economic Research
Department of Economics
University of Pennsylvania
3718 Locust Walk
Philadelphia, PA 19104-6297
pier@econ.upenn.edu
http://economics.sas.upenn.edu/pier

PIER Working Paper 10-013

"Environmental Economics and Venture Capital"

by

Emanuel Shachmurove, Esq. and Dr. Yochanan Shachmurove

http://ssrn.com/abstract=1588091

Environmental Economics and Venture Capital

By

Emanuel Shachmurove, Esquire

And

Dr. Yochanan Shachmurove

Department of Economics

The City College of the City University of New York

Abstract

What are the effects of macroeconomic variables on venture-backed capital investment in environmentally friendly industries in the United States? What is the significance of location in determining both, the number of deals and amount of investment by venture capital in the Clean-tech industry? The Clean-tech sector encompasses those firms that actively incorporate environmental concerns into their products and services. The sector contains environmentally progressive companies from many different traditional, functionality-based industries such as software, energy, telecommunications, etc. This paper ascertains the effects of macroeconomic variables and the location on venture-capital backed investment in the Clean-tech industry in the United States.

JEL Classification: C12, D81, D92, E22, G12, G24, G3, M13, M21, O16, O3

Key Words: Venture Capital; Clean-Technology Industry; Economic Geography; Location; Environmental Economics; Industrial Sector

The research leading to this paper has been partially supported by the Ewing Marion Kauffman Foundation and the Shwager Fund at The City College of The City University of New York, and by a grant from PSC-CUNY. All remaining errors are ours. We would like to thank Tucker Wood of the University of Pennsylvania for his excellent research assistance. All remaining errors are ours.
Please address all correspondence to: Professor Yochanan Shachmurove, Department of Economics, University of Pennsylvania, 3718 Locust Walk, Philadelphia, PA 19104-6297. Email address: yshachmurove@ccny.cuny.edu

Venture-Backed Capital Investment in the Clean-Technology Industry in the United States

I. Introduction

The increased importance of environmental considerations and clean-tech technology cannot be exaggerated. For example, The Time (2009) issues a special annual report on what the magazine calls the Heroes of the Environment paying tribute to the leaders, entrepreneurs, scientists and activists who are working to help the planet. It seems that the idea of "Let's go green" has become a metaphor for all the evil or good we encounter in the world. The United Nations publishes a Special Climate Change Issue in order to "protect succeeding generations…" (UN Chronicle, 2009).

Cristina Narbona Ruiz, the Spanish Ambassador to the OECD and the former Minister of the Environment in Spain, sees the environment as the central issue, indeed the pillar of human welfare. In the current economic system, she sees greed and wastefulness rather than responsibility and prudence. She observes that social inequalities and what she called the systematic destruction of the Earth's ecosystem have escalated. According to her, the lack of regulation and insufficient public oversight are the main causes of the current and projected state of the environment.

Figures 1 and 2 exhibit the trend in Carbon Dioxide released to the atmosphere in million of metric tons from the year 1971 until 2007, the last year that data are available through the International Energy Agency. **Figure 1** presents the data for Spain and the United States. **Figure 2** shows the data for the world, OECD total, and the United States.

Ruiz (2009) cites the United Nations Intergovernmental Panel on Climate Change, which estimates that by 2020 more than 400 million Africans will be severely affected by global warming. She also reports that almost 80 percent of the World's fishing grounds are already exhausted or on the brink of depletion due to overfishing. Ruiz (2009) raises awareness of the threats to public health from air, water and ground pollution, particularly in the poorest countries and developing economies. She presents statistics that show that one million people die each year in China solely from pollution-related causes (see also, the World Bank, 2007). Scarce drinking water and inadequate sewage treatment is the number one cause of disease in the world (see, for example, the United Nations Environmental Program, 2003 and the World Water Assessment Program, WWAP, 2007).

This anticipation of favorable government policies and the resulting diversion of resources to investment in clean-tech industry are echoed also in the more popular media. For example, *The Economist* (Nov. 6, 2008) argues that governments will likely support the Clean-tech sector, as related public policy provides stimulus for the economy, while simultaneously addressing global climate change. The publication however warns that recent decreases in oil prices and stalling credit markets have slowed aggregate venture capital investment, including investment in the Clean-tech sector.

Additionally, *The Economist* (May 1, 2008) cites a lack of entrepreneurial talent and stagnation in the development of new technologies as major impediments to stimulate Clean-tech investment. However, the article predicts that the current recession will only result in a short depression in Clean-tech investment. *The Economist (Nov. 6, 2008)* points out that many orders of wind turbines and solar panels have been placed on

hold until the national economy recuperates. Hence, the drop in clean energy investment is anticipated to be largely temporary. Furthermore, other countries that pollute heavily such as The United Arab Emirates and China are investing hundreds of millions of dollars in environmentally friendly projects. The need for clean technologies to replace processes based on limited fossil fuel energy will still be present after the economic crisis subsides.

This paper studies venture capital investment activity in the Clean-tech sector of the United States during the period 1995 to 2009, Quarter 1 (2009Q1). The Clean-tech sector encompasses those firms that actively incorporate environmental concerns into their products and services. The sector contains environmentally progressive companies from many different traditional, functionality-based industries such as software, energy, telecommunications, etc. The data are taken from The MoneyTree Survey, which is a collaborative effort among PricewaterhouseCoopers, Thomson Venture Economics and the National Venture Capital Association in order to keep track of investment activity backed by venture capitalists in the clean-tech sector.

This paper examines the effects of various macroeconomic variables known to affect investment in general and applies these measures to the study of investment in the Clean-tech sector which is backed by venture capital. Accordingly, the venture capital data are augmented by the Consumer Price Index (CPI), Nominal Gross Domestic Product (NGDP), and the Real Gross Domestic Product (RGDP). As for U.S. interest rates the papers uses three, five and 10-year interest rates and the Federal Fund interest rate. To consider expectations with regards to future prospects of the economy, the Consumer Confidence Index is used.

A long-run perspective is taken in order to explore temporal dynamic movements in Clean-tech venture capital investment. These trends in Clean-tech investment are compared with trends in the aggregate investment in the venture capital market. Additionally, an attempt is made to investigate the importance of the location of the clean-tech investment. This line of research on the importance of geography is motivated by the work of the 2008 Nobel Laureate, Paul Krugman (Krugman, 2009), among others. The data used in this paper is further stratifies to venture capital investment in nineteen regions in the United States.

Statistical as well as graphical methods are used to ascertain the dynamic nature of the data. Pearson correlation coefficients and regression parameter estimates are used to explore how different variables affect the Clean-tech venture capital market. Both investments in dollars and number of deals are analyzed in order to provide a robust check for the findings of this paper.

The statistical findings lead to several conclusions. First, large scale venture capital investment and number of deals in the Clean-tech industry is relatively new and has increased dramatically since the beginning of 2006. Thus, even in the period when aggregate venture capital activity is decreasing, Clean-tech is undergoing an increase in investment. Clean-tech investment is only weakly associated with aggregate national venture capital investment and tends to follow its own independent path over the period. Despite the recent economic crises, Clean-tech investment increased throughout 2008. Only recently, in 2009Q1, has the current global recession caught up to the Clean-tech industry, decreasing venture capital investment activity directed to the sector.

The remainder of the paper is organized into the following part. Part II presents a brief literature review. Part III introduces the data. Part IV describes the empirical results. Part V concludes.

II. Literature Review

Since 2004, the Organization for Economic Development and Co-Operation (OECD) has been regularly publishing its costs of inaction on environmental policy, see for example the recent publications (OECD 2008A, 2008B). The World Bank has adopted the methodology used by the OECD to more countries (see, World Bank, 2006, 2007). The call for increased use of cleaner technology is echoed in the U.K. Stern Review (Stern, 2006, 2008, Nordhaus, 2007a, 2007b, and Weitzman, 2007). The Stern team, as they are famously called, is based at the U.K. Department of Energy and Climate Change.

Chichilnisky and Sheeran (2009) vividly detail the path to Kyoto, Copenhagen and beyond. Chichilnisky (2009) and Chichilnisky and Eisenberger (2009a, 2009b) offer some financial innovations to potentially end the impasse between industrial and developing nations in implementing the Kyoto Protocol and promoting a Copenhagen solution. World leaders are scheduled to meet in Copenhagen in December 2009 to carve out a new global pact to replace the Kyoto Protocol. The United States is the only major developed economy not bound by mandatory caps. At the time of this writing it seems the meeting is unlikely to yield a binding deal.

Stiglitz, Sen and Fittoussi (2009) calls for a paradigm shift which will recognize the right to dignified life for all the citizens and future generations of the planet. In this

respect their ongoing project suggests a new measurement of economic performance and progress which takes into account quality of life, sustainable development and the environment in measuring happiness of a country. In this context, see also United Nations (2003, 2005) and the report by UNECE/OECD/Eurostat (2008). For an earlier literature see, among others, Weitzman, (1976), Cobb and Daly (1989), Cobb and Cobb (1994), Desai (1994) , Dasgupta, (2001), Arrow, Dasgupta, and Mäler (2003), Arrow, Dasgupta, Goulder, Daily, Ehrlich, Heal, Levin, Mäler, Schneider, Starrett, and Walker, (2004), Abraham and Mackie (2005), and Arrow, Dasgupta, Goulder, Mumford and Oleson (2008).

The analysis of the Clean-tech industry is relatively new. Burtis (2004) examines a cluster of Clean-tech firms in California, showing that both venture capital investment and government policy are the largest determinants in determining whether the industry succeeds or fails. He argues that one region of the United States will likely become a Clean-tech focal point since venture capital investment tends to be funneled into geographical hubs that become the leaders in their relative industrial sectors. Stack (2006) notes that energy prices, entrepreneurial talent, and technological advances are key factors in the growth of the Clean-tech industry. He argued that the rising public discussions about trends in global warming and depletion of natural resources are promoting venture capitalists to invest in Clean-tech firms expecting more favorable and supportive government policies toward a cleaner environment.

The emergence of the new economic geography can be attributed to the pioneering works of Krugman (Krugman, 1991a, 1991b, 1998) Fujita and Krugman (2004), and Venables (1996, 1998, 2003). Krugman (1991a) examines the uneven

economic development of different regions, emphasizing the importance of economic geography in explaining divergent regional development. Krugman (1991b) shows that a country can endogenously become differentiated into an industrialized "core" surrounded by an agricultural "periphery." Krugman (1998) discusses the emergence of the 'new economic geography,' a new area of research that solves some areas of incongruence in economic theory. It differs from traditional work in economic geography by incorporating a modeling strategy that uses the same technical and mathematical tools found in the 'new trade' and 'new growth' theories.

In the context of venture capital literature, Murphy (1956) provides the pioneering study, based on one hundred start-up firms. Others have also studied the importance of industry choice in achieving start up success. Shachmurove A. and Shachmurove Y. (2004) explore annualized and cumulative returns on venture-backed public companies categorized by industry. Annual and cumulative returns of publicly traded firms who were backed by venture capital are studied in series of papers by Shachmurove, Y. (2001), and Shachmurove, A. and Shachmurove, Y (2004). Shachmurove, Y. (2006) examines venture capital investment activity in the United States for the years 1996 – 2005. Shachmurove (2007) relates issues in international trade to entrepreneurship, innovation, and the growth mechanism of the free-market economies.

III. Data

The data on venture capital investment activity in the United States are from The MoneyTree Survey. The survey is a quarterly study of venture capital investment activity in the United States (U.S.), which measures cash for equity investments by the

professional venture capital community in private emerging U.S. companies. The survey is collaboration between PricewaterhouseCoopers and the National Venture Capital Association based upon data from Thomson Reuters. The survey is the only industry-endorsed research of its kind. The MoneyTree Report is conceived to be the definitive source of information on emerging companies that receive financing and the venture capital firms that provide it. The study is considered a staple of the financial community, entrepreneurs, government policymakers and the business press worldwide.

The survey includes the investment activity of professional venture capital firms with or without a U.S. office, Small Business Investment Companies (SBICs), venture arms of corporations, institutions, investment banks and similar entities whose primary activity is financial investing. In cases where there are other participants such as angels, corporations, and governments in a qualified and verified financing round, the entire amount of the round is included. Qualifying transactions include cash investments by these entities either directly or by participation in various forms of private placement. All recipient companies are private, and may have been newly-created or spun-out of existing companies.

The survey excludes debt, buyouts, recapitalizations, secondary purchases, Initial Public offerings (IPOs), investments in public companies such as PIPES (private investments in public entities), investments for which the proceeds are primarily intended for acquisition such as roll-ups, change of ownership, and other forms of private equity that do not involve cash such as services-in-kind and venture leasing.

The macroeconomic data include the Consumer Price Index (CPI), the Producer Price Index (PPI), Nominal Gross Domestic Product (NGDP), and the Real Gross

Domestic Product (RGDP). The data source is the U.S. Bureau of Economic Analysis. The three, five and 10-year interest rates and the Federal Fund interest rate are from the Federal Reserve Statistical Release. The Consumer Confidence Index is published monthly by the Conference Board. The Index is constructed using the Consumer Confidence Survey which is based on a representative sample of 5,000 U.S. households. All the data are from 1995 to 2009, Quarter 1.

IV. Empirical Results

Figure 3 presents the data for the number of deals that are backed by venture capital in the Clean-Tech industry for the period of the study, namely from 1995 until 2009, Quarter 1. **Figure 4** shows real investment backed by venture capital in the Clean-Tech Industry for the same period. As shown in the two figures, Clean-tech deals and investment activity were roughly stable from 1995 to 2005 and then experienced a period of rapid growth from 2005 to 2008. This increase in number of deals and investment are unique since it took place partly during a recession. It seems that investment in Clean-tech is more isolated from downturns in the general economy. However, Clean-tech investment did fall in 2009Q1, indicating that the current global economic crisis may have finally caught up to Clean-tech investment.

Figure 5 displays Clean-tech investment stratified by region from 2007 to 2009Q1. Regional data for Clean-tech investment is not available before 2007. Nevertheless, the Figure clearly shows that Clean-tech investment varies considerably by region, indicating that region is a significant factor in determining Clean-tech investment.

Silicon Valley dominates every other region in Clean-tech investment over both the boom and bust periods.

Table 1 presents summary statistics for the variables used in this study. Note that IR3, IR5 and IR 10 stand for interest rates for 3, 5 and 10 years. **Table 2** presents the Pearson Coefficients and their corresponding significant values for the variables used in the study. Clean-tech investment and number of deals of such investment are highly correlated, with a Pearson coefficient of 0.96. All interest rates are significantly negatively correlated with both the Consumer Price Index and with the Producer Price Index. It is interesting to note that whereas the Consumer Confidence Index is positively correlated with ventured backed total investment and total deals, it is negatively correlated with clean-tech investment and clean tech deals. As one may expect, real GDP is positively correlated with total investment and Clean-tech investment. However, GDP is more strongly correlated with Clean-tech investment than U.S. aggregate venture capital investment. Furthermore, Clean-tech investment and number of deals are negatively correlated with all the interest rates in the study, i.e., the Federal Funds, the three, five and ten-year interest rates. This is interesting because aggregate venture capital investment is positively correlated with the 3-year interest rate, indicating that total investment and Clean-tech investment have fundamental differences over the period 1995 to 2009Q1.

Aggregate venture capital and Clean-tech investments have a small correlation (0.07), indicating that there is low association between the two variables. In other words, movements in aggregate venture capital investment do not have a large effect on Clean-tech investment. Total investment and Clean-techs deals have a small negative Pearson

coefficient (-0.04), strengthening the conclusion that Clean-tech investment has little association with national aggregate investment over the period.

Table 3 presents the final regression results for the number of deals in the Clean-tech industry in the United States during the period of this study, 1995 through 2009, Quarter 1. The independent variables include in addition to a constant, date and date squared, total ventured-backed deals, real total investment , real gross domestic product, the three-year interest rate, and the Consumer Price index. The adjusted R^2 is 0.92. All variables are significant with below 0.02 levels.

As expected, aggregate venture-backed deals positively affects the number of deals in the clean-tech industry. As may be expected, real GDP has a positive parameter coefficient. Despite the recent rise in Clean-tech investment during the recession year of 2008, number of deals in the Clean-tech industry is still positively associated with GDP over the period. The 3-year interest rate has a negative parameter coefficient. The date-trend variable has a negative coefficient, while the date-trend squared has a positive coefficient. The parabolic nature of the number of deals in the clean-tech industry could cause a positive association with the square of the date variable; since number of deals in the Clean-tech industry is better estimated with a quadratic time trend than with only the trend variable present (see ***Figures 3 and 4***). The rapid increase in the number of Clean-tech deals from 2006 to 2008 broke its previous approximately linear trend. The regular date variable is strictly linear, and thus may be a weaker determinant of number of deals in the Clean-tech industry. To strengthen this conclusion, the residual plot of the date (available upon request) shows larger residual values near the end of the period than does the trend-squared residual plot.

Table 4 presents the regression results for real Clean-tech investment which is backed by venture capital for the period 1995 through 2009, Quarter 1. The variables found to affect this variable are, in addition to a constant, date and date squared, are real total investment by venture backed capital, real GDP, the three-year interest rate and the CPI. All variables are statistically significant at or below 0.02. It is interesting to note that once one uses regression analysis, real total investment backed by venture capital is positively affecting investment in real clean tech industry. The same is true with real Gross Domestic Product, although one notes that the coefficient of this variable is huge relative to the former variable. As one may expect from the previous result with regards to the three-year interest rate, its effect is negative on venture backed real investment in the clean-tech industry. Also, the positive affect of the consumer price index is interesting because it points out the phenomenon that an increase in the CPI attracts more investment. It represents expectations about future favorable condition in the economy above and beyond the positive affect of current real GDP.

V. Conclusion

The increased importance of environmental considerations and clean-tech technology cannot be exaggerated. This paper studies the number of deals and real investment in the Clean-Technology industry of the United States that are backed by venture capital. The effects of macroeconomics variables are investigated. The dataset for this part spans from 1995 until 2009, Quarter 1. This paper further explores the effects of location and geography on investment and number of deals in this industry using a unique dataset for the years 2007 through 2009, Quarter 1. The results confirm

the significance of geography in determining Clean-Technology investment and number of deals.

The number of deals in the Clean-tech industry is significantly affected by total ventured-backed deals, real total investment, real gross domestic product, the three-year interest rate, and the Consumer Price index. Real investment in the Clean-tech industry is affected by real total investment by venture backed capital, real GDP, the three-year interest rate and the CPI.

Future research will be directed in obtaining more comprehensive regional data for the clean-tech industry. This paper is taking the first few steps in the direction of explaining investment in the clean-tech industry.

References

Abraham K. and C. Mackie, eds. (2005), *beyond the Market Designing Nonmarket Accounts for the United States,* National Academy of Sciences, Washington D.C.

Arrow, K.J., Dasgupta, P. And Mäler, K.G. (2003) "Evaluating projects and assessing sustainable development in imperfect economies", *Environmental and Resources Economics*, 26: 647-685.

Arrow, K.J., Dasgupta, P., Goulder, L., Daily, G., Ehrlich, P., Heal, G., Levin, S., Mäler,K.G., Schneider, S., Starrett, D . and Walker, B.(2004) "Are We Consuming Too Much?", *The Journal of Economic Perspectives*, 18 (3): 147-172

Arrow, K.J., Dasgupta, P., Goulder, L.H., Mumford, K. and Oleson, K. (2008) "China, the U.S., and Sustainability: Perspectives Based on Comprehensive Wealth", Working Paper No. 313, Stanford Center for International Development, Stanford University.

Behrens, K., (2005), "Market Size and Industry Location: Traded vs. Non-traded Goods," *Journal of Urban Economics*, vol. 58, no. 1, pp. 24-44, July.

Burtis, P. (2006), "Creating Clean-tech Clusters: 2006 Update," *Environmental Entrepreneurs*.

Chichilnisky, Graciela (2009), "Financial Innovations and Carbon Markets," UNChronicle, Volume XLVI, Number 3&4, pp. 63-69.

Chichilnisky, Graciela and Eisenberger, Peter, (2009a), "How Air Capture Could Help to Promote a Copenhagen Solution," Nature, Vol. 495, 25 June 2009.

Chichilnisky, Graciela and Eisenberger, Peter, (2009b), "Energy Security, Economic Development and Global Warming: Addressing Short and Long Term Challenges," International Journal of Green Economics.

Chichilnisky, Graciela and Sheeran, A. Kristen, (2009), Saving Kyoto: An Insider Guide to How it Works, Why it Matters and What it Means for the Future, New Holland Publishers (UK) Ltd.

Clean Tech in China. The Economist July 19, 2007.

Cobb, J. and Daly, H. (1989) *For the Common Good, Redirecting the Economy Toward Community, the Environment and a Sustainable Future*, Boston, Beacon Press.

Cobb, C.W. and Cobb, J. (1994) *The Green National Product*, Lanham, University Press of America.

Dasgupta, P. (2001) "Valuing Objects and Evaluating Policies in Imperfect Economies", *The Economic Journal*, 111: C1-C29.

Desai, M. (1994) "Greening the HDI?" in The New Economic Foundation (Eds) *Accounting for change*, MacGillivray.

Fujita M., and Krugman P., (2004), "The New Economic Geography: Past, Present and the Future," *Papers in Regional Science*, vol. 83, no. 1, pp. 139-64, January.

Gathering Clouds. The Economist Nov. 6, 2008.

Krugman P. (1999), *Geography and Trade. Gaston Eyskens Lecture Series,* Cambridge, Mass. and London: MIT Press, and Louvain, Belgium: Louvain University Press, pp. xi, 142.

Krugman, Paul, (1991), "Increasing Returns and Economic Geography," *Journal of Political Economy*, vol**.** 99, no. 3, pp. 483-99, June.

Krugman, Paul, (1995), "Innovation and Agglomeration: Two Parables Suggested by City-Size Distributions," *Japan and the World Economy*, vol. **7**, no. 4, pp. 371-90, November.

Krugman, Paul, (1998), "What's New about the New Economic Geography?" *Oxford Review of Economic Policy*, vol. 14, no. 2, pp. 7-17, Summer.

Krugman, Paul, (2009), "The Increasing Returns Revolution in Trade and Geography," American Economic Review, vol. 99, no. 3, June, pp. 561-71

Masdar Plan. The Economist Dec. 4, 2008.

Midelfart, K.H., Overman, H., Venables, A.J., (2003), "Monetary Union and the Economic Geography of Europe," *Journal of Common Market Studies*, vol. 41, no. 5, pp. 847-68, December.

Murphy, T. (1956), *A Business of Your Own*, New York: McGraw-Hill.

Nordhaus, W.D. (2007A), "The Challenge of Global Warming: Economic Models and Environmental Policy" Yale University, Department of Economics Discussion Paper (http://nordhaus.econ.yale.edu/dice_mss_072407_all.pdf).

Nordhaus,W.J. (2007B) "The Stern Review of the Economics of Climate Change", *Journal of Economic Literature*.

OECD, Organization for Economic Development and Co-Operation (2008), OECD Key Environmental Indicators.

OECD, Organization for Economic Development and Co-Operation (2008), "COSTS OF INACTION ON ENVIRONMENTAL POLICY CHALLENGES: SUMMARY REPORT [ENV/EPOC(2007)16/FINAL] Meeting of the Environment Policy Committee (EPOC) at Ministerial Level Environment and Global Competitiveness 28-29 April.

OECD (2008), *OECD Environmental Outlook to 2030*, OECD, Paris.

Ruiz, Narbona Cristina, "A Stronger, Cleaner and Fairer Economy: Towards a New Paradigm," OECD Observer, No 273, June 2009, pp. 30-31.

Seeking New Entrepreneurs. The Economist May 1, 2008.

Shachmurove, Emanuel and Shachmuorove, Yochanan (2009), "The Rise of Clean-technology Venture Capital Market in the United States, 1995-2008," Polish Journal of Environmental Studies, Volume 18 (forthcoming)

Shachmurove, Yochanan (2007), "Innovation and Trade: Introduction and Comments," in Eytan Sheshinski, Robert J. Strom and William J. Baumol (eds.), *Entrepreneurship, Innovation, and the Growth Mechanism of the Free-Enterprise Economies*, Princeton University Press, pages 247 -260.

Shachmurove, Yochanan (2006), "An Excursion into the Venture Capital Industry Stratified by Locations and Industries 1996-2005," *The Journal of Entrepreneurial Finance and Business Ventures*, vol. 11, no. 3, pp. 79 – 104, December.

Shachmurove, Yochanan (2001), "Annualized Returns of Venture-Backed Public Companies Categorized by Stage of Financing," *Journal of Entrepreneurial Finance*, Volume 6, Number 1, Pages 44 - 58.

Shachmurove, Amir and Shachmurove, Yochanan, (2004), "Annualized and Cumulative Returns on Venture-Backed Public Companies Categorized by Industry," *The Journal of Entrepreneurial Finance and Business Ventures*, Volume 9, Issue Number 3, December, pp. 41-60.

Stack, J., (2006), "Cleantech Venture Capital: How Public Policy Has Stimulated Private Investment," *Environmental Entrepreneurs*, May.

Stern, N. (2006) "The Economics of Climate Change: The Stern Review", H.M. Treasury, U.K.

Stern, N. (2008) "The economics of climate change", *American Economic review*, Papers and Proceedings, 2008.

Stiglitz, Joseph E., Sen, Amartya, and Fitoussi, Jean-Paul (2009), "Report by the Commission on the Measurement of Economic Performance and Social Progress," available at www.stiglitz-sen-fitoussi.fr.

Time (2009), "Special Report: Heroes of the Environment,'" October 5.

UNEP (UN Environmental Programme) (2003), "Groundwater and its Susceptibility to Degradation: A Global Assessment of the Problem and Options for Management" http://www.unep.org/DEWA/water/GroundWater/groundwater_report.asp)

USEPA (1999), "The Benefits and Costs of the Clean Air Act 1990 to 2010", EPA Report to Congress, Report EPA-410-R-99-001, November.

UNECE/OECD/Eurostat (2008) "Report on measuring sustainable development: statistics for sustainable development, commonalities between current practice and theory", Working Paper ECE/CES/2008/29.

United Nations (2003), Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003.

United Nations (2005) Living Beyond Our Means: Natural Assets and Human Well-being.

UNChronical, (2009), United Nations in a United Way, Special Climate Change Issue, Volume XLVI, Number 3&4, 2009.

Venables, A.J., (1996) "Equilibrium Locations of Vertically Linked Industries," *International Economic Review*, 37: 341–359.

Venables, A.J., (1998), "The Assessment: Trade and Location," *Oxford Review of Economic Policy*, vol. 14, no. 2, pp. 1-6, Summer.

Venables, A.J., (2003), "Trade, Geography, and Monopolistic Competition: Theory and an Application to Spatial Inequalities in Developing Countries," *Economics for an Imperfect World: Essays in Honor of Joseph E. Stiglitz*, pp. 501-17.

Weitzman, M.L. (1976), "On the Welfare Significance of National Product in a Dynamic Economy", *Quarterly Journal of Economics* 90, 156-162.

Weitzman, M. (2007), "The Stern Review of the Economics of Climate Change", *Journal of Economic Literature.*

World Bank (2006), *Hazards of Nature, Risks to Development* (Washington D.C.: World Bank).

World Bank (2007) *Cost of Pollution in China: Economic Estimates of Physical Damages* (Washington D.C., World Bank).

WWAP (World Water Assessment Programme) (2007), **http://wwap.unesco.org/**.

Table 1: Summary Statistics for the Variables Used in this Study

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
DATE	57	29	16.59819	1653	1	57
Date squared	57	1112	993.1676	63365	1	3249
CPI	57	180.62456	19.43869	10296	150.9	219.3
PPI	57	143.12865	20.48898	8158	122.6	200.4667
Consumer Confidence Index	57	91.82281	12.2329	5234	57.7	110.1
Total Venture Investment	57	7.423E+09	6.07E+09	4.23E+11	1.64E+09	2.79E+10
Total Deals	57	938.54386	376.7135	53497	421	2128
RGDP	57	10009	1146	570520	7974	11727
NGDP	57	10652	2198	607147	7298	14413
GDP Deflator	57	105.33918	9.92679	6004	91.53	124.113
Federal Funds	57	3.95563	1.88155	225.471	0.233	6.52
IR3	57	4.41032	1.55105	251.388	1.27	7.267
IR5	57	4.69132	1.31727	267.405	1.763	7.393
IR10	57	5.07226	1.02815	289.119	2.737	7.483
Clean-tech Investment	57	203957580	2.88E+08	1.16E+10	14651	1.14E+09
Clean-tech Deals	57	22.7193	19.15608	1295	6	79

IR3, IR5 and IR 10 stand for interest rates for 3, 5 and 10 years.

Table 2: Pearson Correlation Coefficients

	DATE	Date Squared	CPI	PPI	Consumer Confidence Index	Total Investment	Total Deals	RGDP
DATE	1	0.9693 <.0001	0.9916 <.0001	0.8921 <.0001	-0.6728 <.0001	0.0477 0.7246	0.0581 0.6679	0.9915 <.0001
Date Squared	0.9693 <.0001	1.0000	0.9859 <.0001	0.9567 <.0001	-0.7704 <.0001	-0.0550 0.6848	-0.0471 0.7278	0.9427 <.0001
CPI	0.9916 <.0001	0.9859 <.0001	1.0000	0.9406 <.0001	-0.7193 <.0001	0.0259 0.8481	0.0411 0.7613	0.9799 <.0001
PPI	0.8921 <.0001	0.9567 <.0001	0.9406 <.0001	1.0000	-0.7635 <.0001	-0.0386 0.7754	-0.0175 0.8974	0.8736 <.0001
Consumer Confidence Index	-0.6728 <.0001	-0.7704 <.0001	-0.7193 <.0001	-0.7635 <.0001	1.0000	0.3411 0.0094	0.3570 0.0064	-0.5926 <.0001
Total Investment	0.0477 0.7246	-0.0550 0.6848	0.0259 0.8481	-0.0386 0.7754	0.3411 0.0094	1.0000	0.9759 <.0001	0.1393 0.3015
Total Deals	0.0581 0.6679	-0.0471 0.7278	0.0411 0.7613	-0.0175 0.8974	0.3570 0.0064	0.9759 <.0001	1.0000	0.1561 0.2462
RGDP	0.9915 <.0001	0.9427 <.0001	0.9799 <.0001	0.8736 <.0001	-0.5926 <.0001	0.1393 0.3015	0.1561 0.2462	1.0000
NGDP	0.9943 <.0001	0.9822 <.0001	0.9970 <.0001	0.9281 <.0001	-0.6777 <.0001	0.0508 0.7075	0.0660 0.6258	0.9879 <.0001
GDP Deflator	0.9862 <.0001	0.9949 <.0001	0.9956 <.0001	0.9445 <.0001	-0.7286 <.0001	-0.0179 0.8951	-0.0055 0.9677	0.9682 <.0001
Federal Funds	-0.5620 <.0001	-0.4957 <.0001	-0.5115 <.0001	-0.3317 0.0117	0.5692 <.0001	0.2991 0.0238	0.3314 0.0118	-0.5023 <.0001
IR3	-0.7222 <.0001	-0.6635 <.0001	-0.6812 <.0001	-0.5137 <.0001	0.6758 <.0001	0.2570 0.0537	0.2711 0.0414	-0.6692 <.0001
IR5	-0.7798 <.0001	-0.7257 <.0001	-0.7414 <.0001	-0.5814 <.0001	0.6886 <.0001	0.2319 0.0826	0.2389 0.0735	-0.7316 <.0001
IR10	-0.8462 <.0001	-0.7886 <.0001	-0.8091 <.0001	-0.6514 <.0001	0.6639 <.0001	0.1603 0.2337	0.1563 0.2455	-0.8111 <.0001
Cleantech Investment	0.7042 <.0001	0.7899 <.0001	0.7713 <.0001	0.8728 <.0001	-0.6690 <.0001	0.0692 0.6093	0.1153 0.393	0.6964 <.0001
Cleantech Deal	0.7829 <.0001	0.8708 <.0001	0.8448 <.0001	0.9310 <.0001	-0.7328 <.0001	-0.0383 0.7772	0.0061 0.9641	0.7639 <.0001

Table 2: Continued

	NGDP	GDP Deflator	Federal Funds	IR3	IR5	IR10	Clean-tech Investment	Clean-tech Deals
DATE	0.9943	0.9862	-0.5620	-0.7222	-0.7798	-0.8462	0.7042	0.7829
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Datesquared	0.9822	0.9949	-0.4957	-0.6635	-0.7257	-0.7886	0.7899	0.8708
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
CPI	0.9970	0.9956	-0.5115	-0.6812	-0.7414	-0.8091	0.7713	0.8448
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
PPI	0.9281	0.9445	-0.3317	-0.5137	-0.5814	-0.6514	0.8728	0.9310
	<.0001	<.0001	0.0117	<.0001	<.0001	<.0001	<.0001	<.0001
Consumer Confidence Index	-0.6777	-0.7286	0.5692	0.6758	0.6886	0.6639	-0.6690	-0.7328
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Total Investment	0.0508	-0.0179	0.2991	0.2570	0.2319	0.1603	0.0692	-0.0383
	0.7075	0.8951	0.0238	0.0537	0.0826	0.2337	0.6093	0.7772
Total Deals	0.0660	-0.0055	0.3314	0.2711	0.2389	0.1563	0.1153	0.0061
	0.6258	0.9677	0.0118	0.0414	0.0735	0.2455	0.393	0.9641
RGDP	0.9879	0.9682	-0.5023	-0.6692	-0.7316	-0.8111	0.6964	0.7639
	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
NGDP	1.0000	0.9949	-0.4899	-0.6627	-0.7273	-0.8032	0.7537	0.8283
		<.0001	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001
GDP Deflator	0.9949	1.0000	-0.4958	-0.6664	-0.7301	-0.8002	0.7667	0.8480
	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Federal Funds	-0.4899	-0.4958	1.0000	0.9204	0.8732	0.7797	-0.1734	-0.2464
	0.0001	<.0001		<.0001	<.0001	<.0001	0.1972	0.0647
IR3	-0.6627	-0.6664	0.9204	1.0000	0.9897	0.9401	-0.3715	-0.4444
	<.0001	<.0001	<.0001		<.0001	<.0001	0.0044	0.0005
IR5	-0.7273	-0.7301	0.8732	0.9897	1.0000	0.9781	-0.4190	-0.4990
	<.0001	<.0001	<.0001	<.0001		<.0001	0.0012	<.0001
IR10	-0.8032	-0.8002	0.7797	0.9401	0.9781	1.0000	-0.4618	-0.5478
	<.0001	<.0001	<.0001	<.0001	<.0001		0.0003	<.0001
Clean-tech Investment	0.7537	0.7667	-0.1734	-0.3715	-0.4190	-0.4618	1.0000	0.9642
	<.0001	<.0001	0.1972	0.0044	0.0012	0.0003		<.0001
Clean-tech Deal	0.8283	0.8480	-0.2464	-0.4444	-0.4990	-0.5478	0.9642	1
	<.0001	<.0001	0.0647	0.0005	<.0001	<.0001	<.0001	

Table 3: Regression Results for Number of Deals in the Clean-tech Industry

Total Clean-Tech Deals with the best regression of total clean tech investment

Dependent Variable: Clean-tech Deal

Number of Observations Used 57

Analysis of Variance

Source		DF	Sum of Squares	Mean Square	F Value	Pr > F
Model		7	19176	2739.416	97.72	<.0001
Error		49	1373.595	28.03254		
Corrected	Total	56	20550			

Root MSE	5.29458	R-Square	0.9332
Dependent Mean	22.7193	Adj R-Sq	0.9236
Coeff Var	23.30431		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-522.129	105.453	-4.95	<.0001
Total Deals	1	0.03084	0.01059	2.91	0.0054
DATE	1	-5.85675	1.09446	-5.35	<.0001
Datesquared	1	0.03358	0.00755	4.45	<.0001
RealTotalInvestment	1	-2.07E-07	7.88E-08	-2.63	0.0115
RGDP	1	0.0278	0.01154	2.41	0.0198
IR3	1	-3.9901	1.14327	-3.49	0.001
CPI	1	2.20756	0.561	3.94	0.0003

Table 4: Regression Results for Venture-Backed Investment in the Clean-tech Industry

Dependent	Variable:	Real Clean-tech Industry		
Number	of	Observations	Used	57

Analysis of Variance

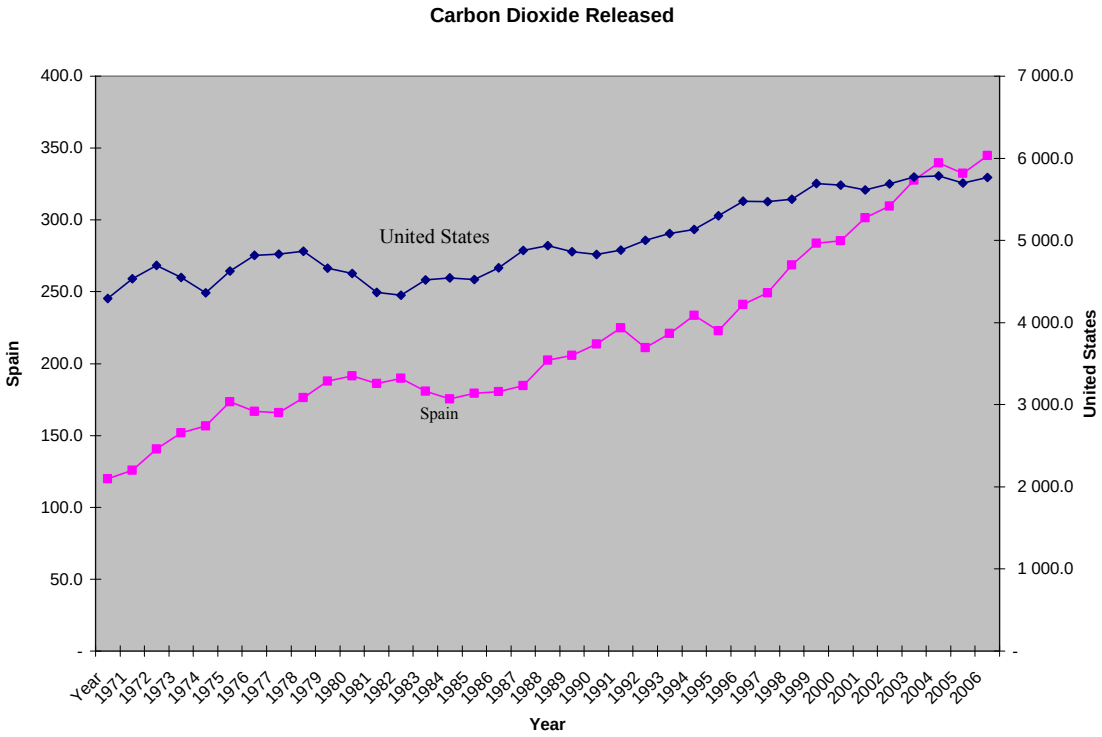
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	1.14E+14	1.89E+13	49.43	<.0001
Error	50	1.91E+13	3.83E+11		
Corrected Total	56	1.33E+14			

Root	MSE	618720	R-Square	0.8557
Dependent	Mean	1237830	Adj R-Sq	0.8384
Coeff	Var	49.98426		

Parameter Estimates

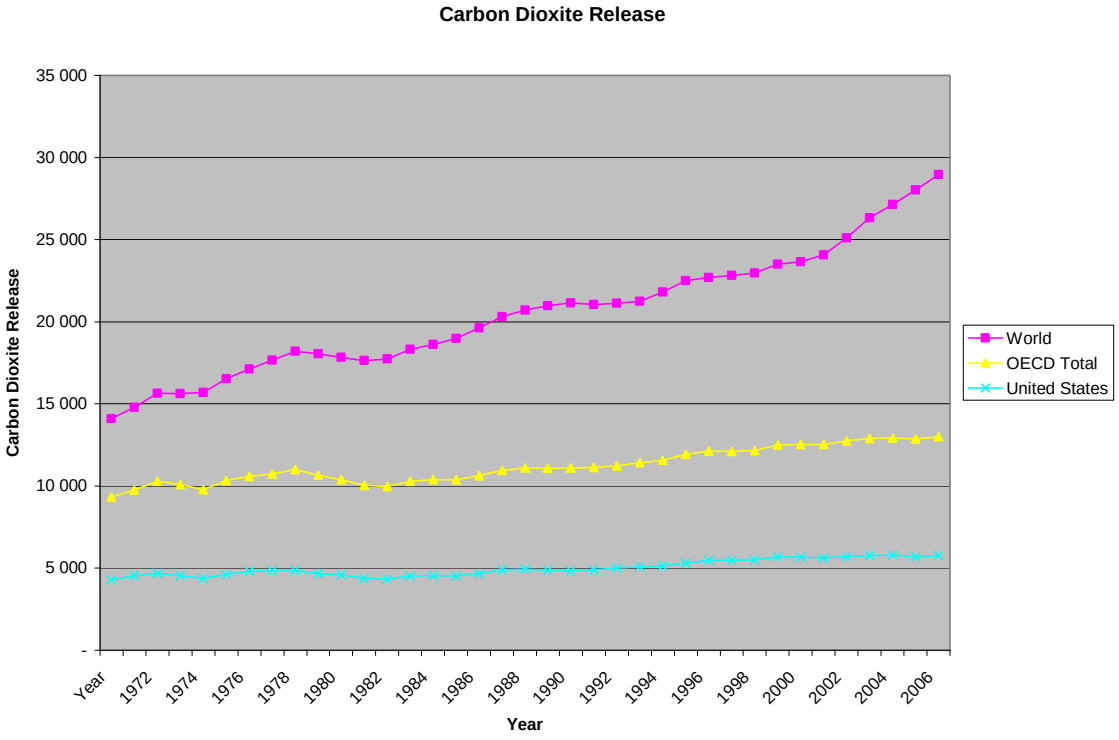
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-65611413	10328698	-6.35	<.0001
DATE	1	-697042	116710	-5.97	<.0001
Datesquared	1	2905.1122	878.5388	3.31	0.0018
RealTotalInvestment	1	0.00606	0.00252	2.4	0.0202
RGDP	1	4044.0335	1272.765	3.18	0.0025
IR3	1	-444213	133574	-3.33	0.0017
CPI	1	249108	60445	4.12	0.0001

Figure 1: Carbon Dioxide Released in Million of Metric Tons, Spain and the United States



Source: International Energy Agency

Figure 2: Carbon Dioxide Released in Million of Metric Tons, World, OECD Total and the United States



Source: International Energy Agency

Figure 3: Venture-Backed Number of Deals in Clean-Tech Industry

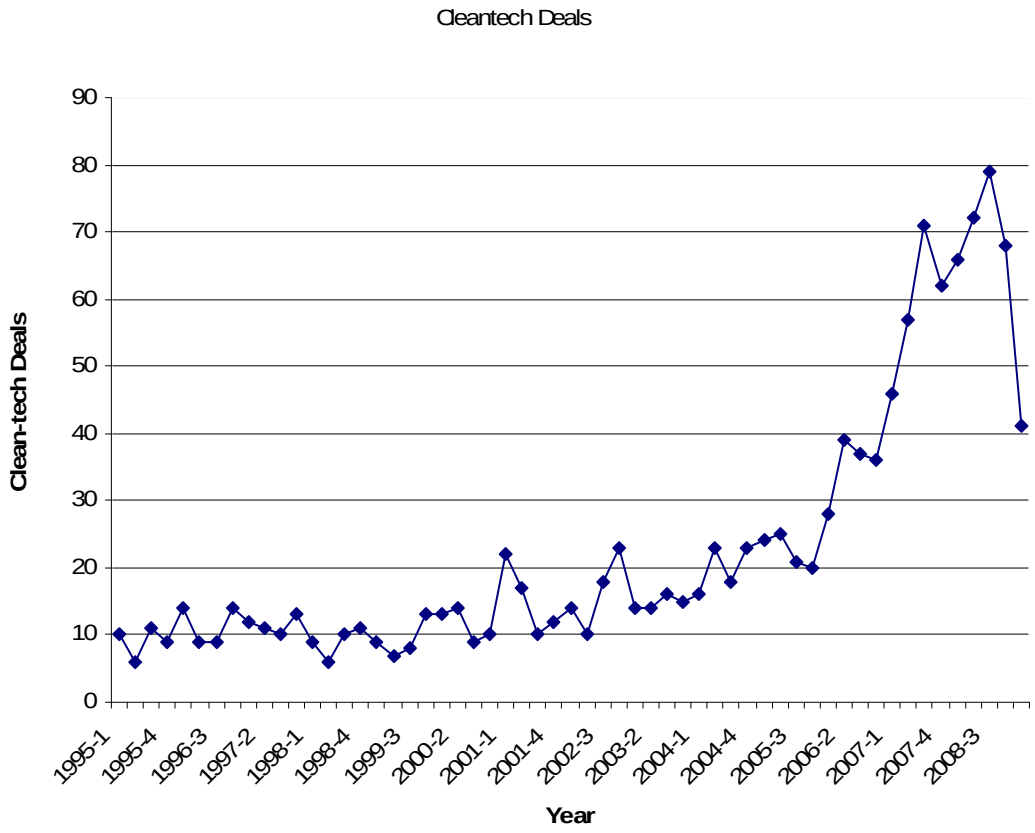


Figure 4: Venture-Backed Real Investment in Clean-Tech Industry

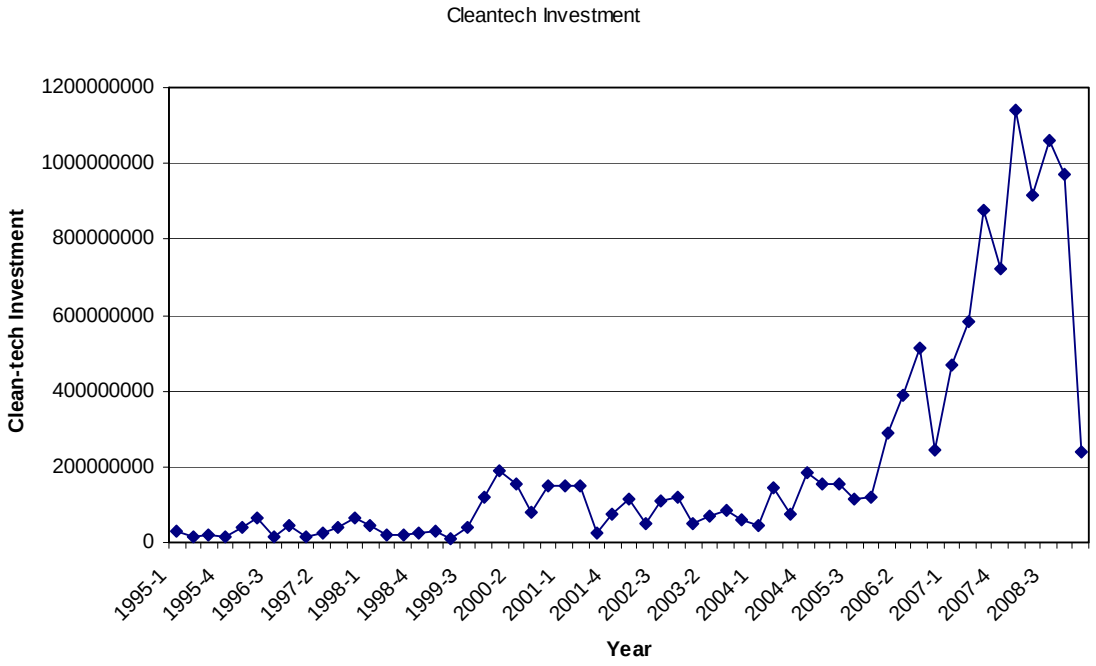


Figure 5: Venture Capital Real Investment in the Venture Capital Industry Stratified by Regions in the United States