Assessing the Economic Impact of Adopting Strategic Trade Controls

U.S. Department of State
Bureau of International Security and Nonproliferation
Office of Export Cooperation

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December 2010

Prepared by The University of Georgia
Center for International Trade and Security
as a team member of
Science Applications International Corporation
under Department of State Task Order S-AQMMA-08-F-6920

Abstract

This study examines the relationship between the introduction of strategic trade controls and a number of indicators for economic performance. Specifically, we examine the contention that trade controls over high technology – in particular, "dual-use" – items inhibit economic growth in general, trade flows in particular. Unlike earlier studies, we are concerned equally with trade controls from both importing and exporting perspectives, with a particular sensitivity to the former as a measure of technology transfer. Technology transfer is an indispensable concept and metric for understanding the reluctance to adopt strategic trade controls as the arguments about such controls have evolved from North-South technology transfer denial issues to concerns about curbs on national economic development. Two hypotheses are tested using data on trade in advanced technology products (ATP) to and from the United States and the EU-15. The results indicate that trade in ATP in the available sample of countries consistently demonstrates that trade was not negatively impacted by the enactment of strategic trade controls legislation. This finding is robust in the univariate development of ATP trade and using several specifications with potential predictors of ATP import/export volumes.

Keywords: strategic trade control; economic development, high technology; dual-use; nonproliferation

Contents

Project Description

EXBS' outreach efforts frequently encounter questions about the economic impact of strategic trade controls. While many believe that strategic trade controls hamper economic development, others contend that strategic trade controls open countries up to new opportunities with technologically advanced partners. To help EXBS better tailor its outreach efforts, ISN/ECC seeks to study the economic impact of effective strategic trade control systems.

The goal of the current study is to assess the impact of effective strategic trade controls on national economies.

The study focused on countries that have established strategic trade control systems for which extensive economic data is readily available, with a focus on non-regime members to the maximum extent practicable.

The goal of the study is twofold:

> A) To determine if strategic trade controls have an impact on national economies; and
> B) To determine the nature of that impact, be it positive or negative, on the economy at large as well as specific, relevant economic sectors.

The study relied upon open source such as trade data, economic indices, and other quantitative and qualitative data as necessary.

1. Introduction

Unlike routinely traded commodities, trade in strategic, or "dual-use," items may pose potentially significant risks with respect to the proliferation of weapons of mass destruction (WMD), as well as to conventional arms. As such, most governments place restrictions on their export, import, and transfer. From the Greek city-states of the classical era to modernity, states and other political entities have used similar trade controls to punish, deter, and weaken adversaries. For example, the United States has a long history of using trade or strategic trade controls to achieve economic, political, and security objectives.[1] During the Cold War the United States joined with its North

[1] The current US system of export controls has roots that reach back to the First World War, when the United States cooperated with Great Britain to institute the "navicert" (i.e., naval certification) system for exports and passed the Trading with the Enemy Act (TWEA). Following the War and the re-armament of Germany in the 1930s, the United States attempted to avoid foreign entanglements by pursuing a policy of neutrality that restricted the export and re-export of military items. Upon

Atlantic Treaty Organization (NATO) allies to restrict trade with the Soviet Union and its Warsaw Pact allies, particularly trade in advanced technologies that could strengthen their military capabilities.[2]

The end of the Cold War marked the end of many export restrictions on trade with Russia and former Soviet bloc states. It did not, however, mark the end of export restrictions. The Gulf War startled the United States and other Western states as they came to discover that Iraq had armed itself largely with assistance from Western suppliers.[3] Iraq had launched a major procurement effort in Western Europe prior to the Gulf War and found German, Swiss, British and even American firms willing to provide technological assistance to Iraqi weapons programs. In some cases, Western companies had exported chemicals, goods, and technologies illegally; in other cases, exports were made out of ignorance.[4]

Over the past decade, continuing concerns about Iran[5] and the efforts of other states to arm themselves with WMD – nuclear, chemical and biological weapons as well as the missiles used to deliver them – have led the United States and other states to establish and tighten regulations governing trade in related weapons technologies.[6] Strategic trade controls, as they are most commonly called, are considered critical for U.S. and international efforts to prevent weapons proliferation. The terror attacks of September 2001 and growing concerns about terrorism have also led U.S. and other international policy makers to consider options for strengthening global export regulations in order to

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becoming a combatant in World War II, the United States extended export controls from purely military items to dual-use items, which are goods, services, and technology which while mainly commercial also have defense applications. This policy was primarily to ameliorate supply shortages in World War II. See, Richard T. Cupitt, *Reluctant Champions: Truman, Eisenhower, Bush, and Clinton: U.S. Presidential Policy and Strategic Export Controls* (Routledge: 2000).

[2] Michael Mastanduno, *Economic Containment: CoCom and the Politics of East-West Trade* (Ithaca: Cornell University Press, 1992), Richard T. Cupitt, *Reluctant Champions: Truman, Eisenhower, Bush, and Clinton: U.S. Presidential Policy and Strategic Export Controls* (Routledge: 2000).

[3] See Douglas Jehl, "Who Armed Iraq. Answers the West Did Not Want to Hear," *The New York Times*, July 18, 1993; Gary Milhollin, "Licensing Mass Destruction, U.S. Exports to Iraq: 1985-1990," *Wisconsin Project Report*, June 1991.

[4] Geoffrey Forden, "How the World's Most Underdeveloped Nations Get the World's Most Dangerous Weapons," *Technology and Culture*, Volume 48, Number 1 (2007), pp. 92-103. See also, United Nations Special Commission (UNSCOM), *Report: Disarmament*, 29 January 1999, S/1999/94, 122.

[5] See, for example, Justin Blum, "Iran Gains U.S. Military Technology Through Malaysia Middlemen," *Bloomberg*, 14 September 2009.

[6] Nonproliferation export controls are the laws, regulations and norms designed to regulate the transfer of weapons of mass destruction components, materials and technologies. Jean-François Rioux ed., *Limiting the Proliferation of Weapons: the Role of Supply-Side Strategies* (Oxford University Press Canada, 1992).

prevent terrorists from acquiring dangerous weaponry and militarily sensitive technologies.[7]

While strategic trade controls over certain types of commodities and technology play a vital security role, they should not, however, restrict legitimate trade. Unlike military materiel, dual-use items – items having both commercial and military applications – are both drivers of globalization and contemporary economic development.[8] In fact, critics of strategic trade controls systems have claimed that proliferation security and economic gains from trade flows often operate in a zero-sum game, particularly for developing economies.[9]

This study examines the relationship between the introduction of strategic trade controls and a number of indicators for economic performance. Specifically, we examine the contention that trade controls over high technology – in particular, dual-use (see Section 2) – items inhibit economic growth in general, trade flows in particular. Unlike earlier studies, we are concerned equally with trade controls from both importing and exporting perspectives, with a particular sensitivity to the former as a measure of technology transfer. Technology transfer is an indispensable concept and metric for understanding the reluctance to adopt strategic trade controls as the arguments about such controls have evolved from North-South technology transfer denial issues to concerns about curbs on national economic development.[10]

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[7] Nick Johnson, "War on Terrorism Poses New Challenges for Technology Exports," *Aerospace Daily*, January 2, 2002; Richard T. Cupitt, Associate Director, Center for International Trade and Security, University of Georgia, Testimony Before the United States Senate Committee on Governmental Affairs, Subcommittee on International Security, Proliferation, and Federal Services on Enhancing Export Controls to Combat Terrorism, November 7, 2001; Sharon Weinberger, "Export Control Changes Will Address Old Issues, New Threats, Says DOD Official," *Aerospace Daily*, March 22, 2002; "House Committee Votes to Toughen Export Controls," *Washington Internet Daily*, March 8, 2002.

[8] See, for example, Matthias Busse and José L. Groizard, "Technology Trade in Economic Development," *The World Economy*, Blackwell Publishing, Vol. 31, No. 4 (2008) pp. 569-592, 04. See also, F. Caselli and D. Wilson, "Importing Technology," *Journal of Monetary Economics*, Vol. 51, No. 1 (2007) pp. 1–32.

[9] Analyst Matthew Fuhrmann notes, "Governments with little experience in this area often perceive that export control directly conflicts with one of their primary objectives—to augment national wealth by promoting exports and imposing few restrictions. They assume, in short, that restricting trade can only stymie economic growth. In many cases, this perception, whether true or not, stymies a country's political willingness to impose export controls." See, Matthew Fuhrmann, "Making 1540 Work: Achieving Universal Compliance with Nonproliferation Export Control Standards," World Affairs, Vol. 169, No. 3, p. 145 (pp. 143-152).

[10] According to a 2004 review of biotechnology export controls: "In addition to restricting movement of dual-use technologies for security-related reasons, export controls also support the economic interests of developed countries. Because they prevent transfer of industry-strategic knowledge and equipment, they contribute to the continuation the North's domination of markets for modern biotechnological products While justified by the rationale that many countries may not be trusted to behave peacefully with certain technology, export controls have the additional "benefit" (from the

The paper begins with an examination of strategic trade controls and related issues of economic development. Next, we review the extant literature on assessing the economic impact of strategic trade controls, with a particular emphasis on quantitative studies. The third section outlines the structure of the study. The fourth section examines strategic trade controls systems and trade volumes, explains the research design, case selection and data sets, identifies our hypothesis, and presents our results. Our results suggest that adoption of strategic trade controls neither negatively impact trade flows in general, nor high technology trade flows in particular. The study concludes by commenting on the implications of these findings and identifies opportunities for future research.

2. Strategic Trade Controls and Economic Development

Since the end of the Second World War and the advent of truly global financial and trade arrangements, the trajectory of global trade has been towards more open and less constrained "free" trade.[11] In the context of economic development, both free trade and, perhaps more critically, trade in high technology items are necessary components of a country's trade policy.[12] The pejorative or reluctant responses to adopting strategic trade controls emanate from this central, unsubstantiated premise: trade controls impair economic growth and/or development. In some more extreme instances, strategic trade controls have been likened to a wider policy of default technology denial:

North's perspective) of reinforcing rich countries' ability to determine how science is used." See, "Export Controls: Impediments to Technology Transfer Under the Convention on Biological Diversity," The Sunshine Project, Backgrounder #13, January 2004 < http://www.sunshine-project.org/publications/bk/bk13.html>.

[11] Carsten Kowalczyk and Raymond Riezman, "Free Trade: What are the Terms-of-Trade Effects?" *Economic Theory*, Number 1, October 2009, pp. 147-161. See also, Helen V. Milner with Keiko Kubota, "Why the Move to Free Trade? Democracy and Trade Policy in the Developing Countries," *International Organization* 59, Winter 2005, pp. 107–143.

[12] A World Bank study concludes that: "[T]he importance of international technology transfer (ITT) for economic development can hardly be overstated. Both the acquisition of technology and its diffusion foster productivity growth. As invention and creation processes remain overwhelmingly the province of the OECD countries, most developing countries *must rely largely on imported technologies as sources of new productive knowledge* (emphasis added). However, considerable amounts of follow-on innovation and adaptation occur in such countries. Indeed, these processes effectively drive technological change in developing nations." Bernard M. Hoekman, Keith E. Maskus, Kamal Saggi, "Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options," World Bank Policy Research Working Paper 3332, June 2004 <http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2004/07/29/000160016_20040729155005/Rendered/PDF/wps3332.pdf>.

> In addition to restricting movement of dual-use technologies for security-related reasons, export controls also support the economic interests of developed countries. Because they prevent transfer of industry-strategic knowledge and equipment, they contribute to the continuation the North's domination of markets for modern biotechnological products While justified by the rationale that many countries may not be trusted to behave peacefully with certain technology, export controls have the additional "benefit" (from the North's perspective) of reinforcing rich countries' ability to determine how science is used ….. [E]xport controls are established and applied in a fundamentally unfair, arbitrary way that is often politically-motivated.[13]

Likewise, the final document from the 2000 Ministerial Conference of the Movement of the Non-Aligned Countries Movement,[14] for example, states:

> We note with concern that undue restrictions on exports to developing countries of material, equipment and technology, for peaceful purposes persist. We emphasize that proliferation concerns are best addressed through multilaterally negotiated, universal, comprehensive and non-discriminatory agreements. Non-proliferation control arrangements should be transparent and open to participation by all States, and should ensure that they do not impose restrictions on access to material, equipment and technology for peaceful purposes r*equired by developing countries for their continued development* (emphasis added).[15]

Arguments of this genre have generally given way to concerns about the negative economic impact of adopting controls,[16] particularly after the passage of United Nations

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[13] See, "Export Controls: Impediments to Technology Transfer Under the Convention on Biological Diversity," (fn. 10). Indian scholar, Brahma Chellaney, noted, in a 1994 article that "The non-proliferation policies of Western powers are founded on a strategy of preventing Third World development of technologies that might impinge on the Western powers' military and economic interests." See, Brahma Chellaney, "An Indian Critique of U.S. Export Controls," *Orbis*, Summer 1994, pp. 439-456.

[14] In a 2001 study of U.S. chemical and biological-related trade controls, Cupitt suggested that select trade data undermined charges of technology denial through export controls. Specifically, Cupitt noted that "[T]he evidence delivered in this study, however primitive the analysis, calls into question the argument that export controls impose a significant economic constraint on the technological and economic development of CWC or BWC signatories by diminishing normal trade flows."

[15] Movement of the Non-Aligned Countries, *Final Document*, XIII Ministerial Conference, Cartagena, 8 and 9 April, 2000, <http://www.nam.gov.za/xiiiminconf/final.htm>. See also, Elizabeth Turpen, *Achieving Nonproliferation Goals: Moving From Denial to Technology Governance*, Policy Analysis Brief, Stanley Foundation <http://www.stanleyfoundation.org/publications/pab/TurpenPAB609.pdf>.

[16] The multilateral export control regimes have sought to off-set these concerns by including in their respective guidelines language to the effect that the goal of (sector-specific) trade controls is to

Security Council Resolution 1540 (2004), which requires all member states to adopt effective strategic trade control systems.[17] Many states have assumed that the adoption of trade controls will limit economic growth, particularly amongst export-led growth economies,[18] thereby resulting in a partial implementation of controls. Partial implementation, moreover, may create proliferation threat externalities as proliferants are able to exploit loopholes in the global supply chain.[19]

The notion of controlling certain types of trade in order to meet international nonproliferation objectives may be counterintuitive, if not contradictory, to most governments unfamiliar with strategic trade controls, insofar as these governments believe that restricting trade can only constrain economic growth.[20] Other studies have made similar observations regarding the dissonance between the concept and implementation of strategic trade controls.[21] To this point, it is of vital conceptual importance that the terms of art be clearly defined, beginning first with "strategic trade controls."

Strategic trade controls are legal, institutional, technical, and cooperative policies, procedures and institutions for selectively controlling the import, (re-)export and transit of strategic, or dual-use, items. United Nations Security Council Resolution 1540 identifies the key elements of effective strategic trade controls. Specifically, the resolution calls for the creation of "effective" laws to control dual-use transfers. Leaving aside the ambiguities inherent in "effective," the resolution outlines a legal basis that

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promote lawful while curbing illegal trade in dual-use commodities and technologies. For example, the NSG states: "The aim of the NSG Guidelines is to ensure that nuclear trade for peaceful purposes does not contribute to the proliferation of nuclear weapons or other nuclear explosive devices, and that international trade and cooperation in the nuclear field is not hindered unjustly in the process." The other regime guidelines contain similar provisions.

[17] In the preamble, UNSCR 1540 emphasizes the importance of protecting the lawful trade in strategic commodities: "Affirming that prevention of proliferation of nuclear, chemical and biological weapons should not hamper international cooperation in materials, equipment and technology for peaceful purposes while goals of peaceful utilization should not be used as a cover for proliferation." As noted in Jones (2006), the Resolution should serve as the starting point for a wider dialogue on how best to manage trade in strategic items, many of which are critical for the development of modern economies."

[18] See Cupitt (2009). Conversely, some countries, such as Singapore, have publicly supported the view that export control can enhance economic performance. For example, at the 14th Asian Export Control Seminar in Tokyo, Japan, the representative from Singapore noted that trade volumes had actually increased *after* the introduction of a comprehensive export control law. Citation from author's notes, 14th Asian Export Control Seminar, 6-8 February 2007.

[19] See, for example, David Albright, Paul Brannan and Andrea Scheel, "A Smuggler's Procurement of Nuclear Dual-Use Pressure Transducers for Iran," ISIS Report, 14 July 2009 < http://isis-online.org/publications/iran/Yadegari_Iran_illicit_trade_14July2009.pdf>. See also, Nuclear Nonproliferation Regime," International *Security*, Vol. 29, No. 2 (2004), pp. 5-49.

[20] See Fuhrmann 2007.

[21] See Cupitt 2008, and Joyner 2006.

addresses brokering transit, transshipment, and re-strategic trade controls and a recommendation for the implementation of sufficient penalties for violations.[22] As the resolution is legally binding, all UN member states must adopt such a legal basis, albeit in a manner according "with their national procedures." Likewise, while outside of the legally compelling paragraphs 1-3, paragraph 6 calls upon states to develop "national control lists and calls upon all Member States, when necessary, to pursue at the earliest opportunity the development of such lists."[23] The Resolution, however, does not *prohibit* the transfer of commodities and technologies related to biological, chemical and nuclear weapons and their means of delivery, as these items have mainly legitimate commercial uses.[24] In this regard, strategic trade controls are a means of selective trade management (i.e., licensing) over a tightly defined set of industrial and technology-related commodities.

The other key conceptual term of this study is "dual-use." In its most general sense, the term refers to items that have both civilian and military applications, although the term "military" is not always consistently specified as referring to conventional weaponry or to WMD. The following citations illustrate the variance in specificity.[25] The European Union defines dual-use as:

> "Dual-use items" shall mean items, including software and technology, which can be used for both civil and military purposes, and shall include all goods

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[22] In addition, states must develop an enforcement capacity to police exports and transfers of sensitive items. States are called upon to "develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat, including through international cooperation when necessary, the illicit trafficking and brokering in such items in accordance with their national legal authorities and legislation and consistent with international law."

[23] A control list for nonproliferation export controls is the legally establish means of verifying the types of goods, services and technologies that will be controlled and therefore reviewed by the licensing system. Control Lists define the products being controlled by describing the technical specifications of items that require a license in order to export. A typical nonproliferation export control list contains categories for nuclear, chemical, biological, missile, dual-use, and conventional weapons technologies. Traditionally, national dual-use control lists are derived from the multilateral export control regimes (Australia Group, Missile Technology Control Regime, Nuclear Suppliers Group, and Wassenaar Arrangement) as a minimal basis for control. The EU control list, for example, is becoming the *de facto* international export control list standard as it is derivative of all of the multilateral export control regimes while allowing for national discretion in adding items. UNSCR 1540, however, does not reference the export control regimes in the context of control lists.

[24] See Cupitt 2009.

[25] The term ''dual-use'' was explicitly used at least as long ago as 1993, when it appeared in a report by the U.S. Office of Technology Assessment (OTA) on the technologies underlying weapons of mass destruction: ''Understanding the extent to which 'dual-use' technologies or products – those also having legitimate applications – are involved in the development of weapons of mass destruction is important, since both the feasibility of controlling dual-use items and the implications of doing so depend on the extent of their other applications.'' Office of Technology Assessment, *Proliferation of Weapons of Mass Destruction: Assessing the Risks*, May 1993, OTA-ISC-559, p. 32. Retrieved from <http://www.au.af.mil/au/awc/awcgate/ota/9341.pdf>

> which can be used for both non-explosive uses and assisting in any way in the manufacture of nuclear weapons or other nuclear explosive devices.[26]

According to the Strategic Goods Control Act (2003) of Singapore:

> " '[D]ual-use goods' means goods capable of being used for both a non-military purpose and a military purpose or relevant activity; 'dual-use technology' means technology necessary for the development, production or use of any dual-use goods."[27]

While variations exist, for the purposes of this study, we will define dual-use as pertaining to both conventional and unconventional weapons applications. The use of Advanced Technology Products (ATP) as our main data set allows the inclusion of both sets of "military" applications (see Section 4.5). Moreover, the term "strategic trade" is defined as trade in dual-use items.

As noted, some governments have expressed concerns about the economic impact of adopting strategic trade controls, that such controls would necessarily constrict trade flows. While much of this premise is predicated on an incomplete understanding of both the form and content of strategic trade controls, quantifying the impact of nonproliferation strategic trade controls on trade flows has proven to be both methodologically and empirically difficult (Cupitt, 2001; Fuhrmann, 2008).[28] Scholarship on this issue is limited to a handful of recent studies.[29] In 2000, Elwell (2000) examined the economic costs of U.S. dual-use strategic trade controls regulations. Elwell determined that trade controls impose a modest, if negligible, downward impact on the

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[26] Council Regulation (EC) No 428/2009 of 5 May 2009 Setting up a Community Regime for the Control of Exports, Transfer, Brokering and Transit of Dual-Use Items (Recast) L-134, §1.1.

[27] Strategic Goods Control Act, 2003, §4a < http://www.customs.gov.sg/stgc/leftNav/ove/Legislation.htm>.

[28] Similarly, Van Atta, et al. (2008) note: "Quantitative assessment of export control impacts is inherently difficult. Export controls are only one of a number of factors impacting the competitive position of companies, and typically they are not the most prominent factor. Competitiveness is more directly impacted by firm-specific issues such as R&D investment, manufacturing efficiency, and market strategies, as well as macroeconomic issues such as skilled labor availability and cost, exchange rate policy, tariffs and legal barriers. Industry cyclicality can also mask – or mimic – export control effects. Hence, even in those industries where export controls appear to play an important role, it is difficult to prove that they actually cause lost market share. The best economic studies satisfy themselves with "sizing up" the problem as opposed to making definitive quantitative estimates. By the same token, it is typically impossible for individual firms to "prove a negative" – i.e., that particular sales were lost due to export controls" (p. 2).

[29] Related economic impact studies of trade controls have focused on sanctions. See, for example, Jiawen Yang, Hossein Askari, John Forrer, and Hildy Teegen, "U.S. Economic Sanctions: An Empirical Study," *The International Trade Journal*, Vol. 18, No. 1 (2004); and Gary Clyde Hufbauer and Barbara Oegg, "The Impact of Economic Sanctions on US Trade: Andrew Rose's Gravity Model," *International Economics Policy Briefs* (April 2003), Number PB03-4 < http://www.iie.com/publications/pb/pb03-4.pdf>.

estimated value of lost export sales, as well as sector-specific costs represented by losses in global competitiveness, decreased ability to develop new products and services, and the loss of profits and jobs. In conclusion, Ewell inferred that "While strategic trade controls have some impact on the economy, the effect may be somewhat overstated by affected groups."[30] Although novel in attempting to quantify the impact of strategic trade controls, the study was not empirically rigorous and did not deploy specific trade and economic data.[31]

In 2001, Richard Cupitt conducted a preliminary analysis of the economic impact of strategic trade controls on transfers of items of chemical and biological (CB) weapons proliferation concern. The findings of the study suggested that strategic trade controls do not impose a significant economic constraint on the technological and economic development of Chemical Weapons Convention (CWC) or Biological and Toxin Weapons Convention (BTWC) signatories by diminishing normal trade flows.[32] At the same time, however, the study did not examine the nature of the impact of the individual economies of the study, and it was focused on the effect of U.S. strategic trade controls on the importing countries.

In his 2009 study, Cupitt found a moderately positive correlation between the adoption of trade controls and robustness of trade in nuclear-related materials.[33] While the study was limited to nuclear-related materials, the findings do suggest, empirically, that trade controls do not necessarily adversely affect trade flows.[34] A similar conclusion is found

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[30] Ewell, *op. cit*., p. 4.

[31] The author presents a series of logical arguments based on classical economic theory, insofar as impediments to trade, by definition, diminish the efficient allocation of domestic resources and "gains from trade." In the U.S. case, however, since export control do not necessarily impede trade or affect a large set of exports, the relative impact, understood against the context of overall U.S. GDP, is minimal. The idea that there are gains from trade is the central proposition of normative trade theory. The seminal paper on the gains from trade is Paul Samuelson (1939, 1962). Max Corden (1984) contains a comprehensive treatment of the theoretical gains from trade literature.

[32] The analysis focused on U.S. CB-related exports to nine countries (China, Cuba, India, Indonesia, Iran, Libya, Mexico, Pakistan, and Sri Lanka) associated with BWC Protocol negotiation working papers that called for an end to the Australia Group and the implementing policies of its adherents. Examining only a select case of chemical commodities and on a non-longitudinal basis, the author strongly emphasized both the limits and, therefore, conclusions of the study. However, his initial findings provided a compelling, empirical case against charges that export controls were impending economic development, particularly amongst the Non-Aligned Movement (NAM) member states. See, Richard Cupitt, Paper Prepared for "Control Regimes for Chemical and Biological Materials: Towards a Safer and More Prosperous World," September 28 – 30, 2001, 648th Wilton Park Conference, UK.

[33] Specifically, Cupitt concludes that "[T]he influence of the nuclear export control variables certainly undermines the argument by States that adopting appropriate effective controls on nuclear related materials could harm trade-led economic growth."

[34] While the study suggested a value neutral impact of export controls on the trading dyads, the highly select focus on trade in nuclear materials necessarily delimits the general applicability of the study's findings, as countries importing and exporting nuclear materials are exceptional cases.

in Matt Fuhrmann's work on the determinants of dual-use trade, although Fuhrmann found that other variables, such as the recipient state's political system, provided an enhanced explanatory basis for dual-use trade between the United States and 128 countries over a ten-year period.[35] In addition to this limited number of empirical studies, there is increasing anecdotal evidence suggesting a positive correlation between the adoption of strategic trade controls and economic development.[36]

Common to all studies of this genre are profound data limitations, principally arising from the trade classification schemes for dual-use items (see Section 4) and data availability issues.[37] To compensate for these limitations, analysts have either focused on one case (Fuhrmann, 2008) – the United States – or have focused on a narrow set of controlled items, such as certain types of nuclear materials and a limited number of controlled chemicals (Cupitt, 2001 and 2009).[38] In a 2007 Joint Research Center of the European Commission study (Cristina Versino, Camelia Ignat and Louis-Victor Bril, 2007), analysts have attempted to apply language technology to dual-use and harmonized tariff codes correlation efforts in order to study more accurately nuclear trade.[39] Limited publicly available information on dual-use exports has also limited case selection, an absence amplified by the limited number of countries actually importing or exporting statistically significant quantities of controlled items.

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[35] See, for example, Matthew Fuhrmann, "Exporting Mass Destruction? The Determinants of Dual-Use Trade," *Journal of Peace Research,* 2008, pp. 633-652.

[36] Various officials from, for example, Singapore and Poland, have made similar public statements. It is important to note, however, that their pronouncements were slightly imprecise insofar as they referenced their national economies in general. Furthermore, it is highly unlikely that these statements are based on actual data, particularly in light of the data limitations noted in this study.

[37] Very few countries publish detailed statistics of dual-use trade. In addition, as Cupitt notes: "The authors of these (i.e., export control impact studies) and other similar studies face some daunting challenges, and had to make difficult compromises with the data at hand or that they developed. Each study, for example, only examines the impact of US trade controls, reflecting some issues of data availability. Perhaps even more problematic, countries rarely use the same methods of classification for data on the licensing of exports and data on exports as measured by customs authorities. Almost all customs authorities, including that of the United States, record trade data using some form of the Harmonized System (HS), where HS codes do not easily match the coding schemes for controlled goods or services, such as that for the widely-used European Union harmonized list of controlled dual-use items."

[38] Both Cupitt (2001) and Fuhrmann (2008) focused on the U.S. for reasons of data availability. Unlike most major economies, the U.S. publishes data, albeit limited, on dual-use trade.

[39] An initial study, the authors were at pains to emphasize that much more work was required to ensure a closer correspondence between trade statistics in general merchandise and dual-use items. For example, the authors note: "Databases on international trade present an interest in export control. At European level, COMEXT by EUROSTAT collects data on trade between EU Member States and non-member countries. Another example is COMTRADE: maintained by the Statistics Division of the United Nations, it provides a worldwide view on trade. In these databases trade data is reported according to product classification schemes that are independent from EU-DU-C. For instance, in COMEXT items are indexed by 'Combined Nomenclature codes' (CN-C) whose structure and granularity reflect customs tariffs and not proliferation concerns (p. 1)."

When a country introduces or enhances its strategic trade control system, domestic economic actors are directly affected.[40] The export licensing process requires detailed procedures for importing and exporting companies before they are able to sell and ship goods to customers in foreign countries. This screening process might constrain the number of potential trading partners for domestic firms, particularly if those trading partners are located in countries of proliferation concern. Additionally, appropriate trade control infrastructure as well as compliance procedures may impose various direct and indirect costs on bureaucracies and businesses.[41] This could potentially reduce the efficiency of production and increase the overhead of government expenditures.[42] In practice, one might thus observe a decrease in actually occurring exports, industrial production in certain sectors, sector-specific employment, and in general economic growth after a country significantly strengthens its strategic trade control system.[43] Nevertheless, the policy animating controls are a significant factor in determining the degree and scope of economic impact.[44]

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[40] Select publications on various aspects of export control systems include: Daniel Joyner and Nathan Busch, eds., *Combating Weapons of Mass Destruction: the Future of International Non-Proliferation Policy*, (University of Georgia Press, 2008); Michael Beck, Richard Cupitt, Seema Gahlaut, & Scott Jones, eds., *To Supply or To Deny: Nonproliferation Export Controls in Five Key Countries*, (New York: Kluwer, 2003); Gary K. Bertsch, with Richard Cupitt and Steve Elliott-Gower, *International Cooperation on Nonproliferation Export Controls* (Ann Arbor, MI: University of Michigan Press, 1994); Gary K. Bertsch, *Export Controls in Transition: Perspectives, Problems, and Prospects* (Durham, NC: Duke University Press, 1992).

[41] A 2007 survey of 202 aerospace companies indicated that compliance costs associated with export controls average $50 million annually and have increased 23% since 2003. The survey also suggested that the indirect costs to the U.S. space industry were significant. Foreign competitors leveraged their countries' more relaxed regulatory climate in marketing their products as "ITAR-free,"(i.e., U.S. munitions control regulations) which purportedly directly affected U.S. companies' ability to compete. Some U.S. companies claimed the European Space Agency (ESA), for example, directed European companies to find non-U.S. sources for space products, and ESA has also funded development of competing products to either avoid ITAR requirements, develop indigenous capabilities, or both. The survey was based on an Air Force Research Laboratory analysis of survey of 202 space companies/business units. Reported in the CSIS report, *Health of the U.S. Space Industrial Base and the Impact of Export Controls* by Pierre Chao, February 19, 2008 <http://www.csis.org/media/csis/pubs/021908_csis_spaceindustryitar_final.pdf>.

[42] See, for example, "Impacts of U.S. Export Control Policies on Science and Technology Activities and Competitiveness," Hearing before the Committee on Science and Technology, House of Representatives, 111th Congress, First Session, 25 February 2009.

[43] Intuitively, it is reasonable to assume that the various costs associated with trade controls would adversely affect a national economy, if in no other form than lost opportunity costs. Still, affixing objective economic measurements to assumed costs has proven elusive. For example, in a 2006 study, the U.S. General Accountability Office (GAO) criticized the Department of Commerce for not developing export control economic impact measurements. See, *Improvements to Commerce's Dual-Use System Needed to Ensure Protection of U.S. Interests in the Post-9/11 Environment*, June 2006, GAO-06-638.

[44] A National Academies studied determined that, in the U.S., "The negative economic impact of export controls on the U.S. economy has stemmed almost entirely from the unilateral aspects of U.S. policy, including restrictions and control practices not followed by U.S. allies and partners in the

As strategic trade controls are relevant only to a select range of goods, we would expect the adoption of controls to affect economies capable of producing said goods. We may also assume that the adoption of controls increase the probability of successfully importing dual-use and related high-technology items as trade controls can provide assurances to the exporting country (Cupitt, 2009). Advanced economies are the prime source for this technology. Almost all of these economies have developed dual-use strategic trade control systems – the United States and Europe being the foremost examples. One key criterion for exporters in these economies in obtaining export licenses is minimizing the risk that these goods will be transferred outside of the original destination country or diverted to a national unconventional weapons program. Appropriate trade control mechanisms in the destination country contribute significantly to reducing this risk. Therefore, it is likely that sound strategic trade control systems actually increase the ability of countries to attract technology exports from foreign countries.[45]

This dynamic has implications beyond trade flows as such. A number of longitudinal economic studies provide evidence that technology imports can be foundational for long-term economic growth. Conolly (2003), for instance, shows that "technological progress in developed countries embodied in high-technology imports has far greater impact on growth than domestic innovation" (p. 19). Eaton and Kortum (1996) also demonstrated this relationship for the set of OECD countries. A more detailed study of Italian economic development over 30 years illustrates these findings by showing that the influx of foreign technology has been a critical source of endogenous growth for the

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Coordinating Committee for Multilateral Export Controls (COCOM)." National Academy of Sciences, *Finding Common Ground: U.S. Export Controls in a Changed Global Environment* (Washington, DC: National Academy Press, 1991). Gary Clyde Hufbauer, *et al*., found that comprehensive U.S. economic sanctions had a sharply negative impact on trade, and that more limited sanctions – specifically including export controls on limited kinds of dual-use items – still produced a hefty cut in trade flows of one quarter to one third. Gary Clyde Hufbauer, Kimberly Ann Elliott, Tess Cyrus, and Elizabeth Winston, "US Economic Sanctions: Their Impact on Jobs, Wages, and Trade," *Working Papers 1997,* (Washington, DC: The Institute for International Economics, 1997).

[45] In terms of the technology transfer benefits for importing countries of adopting trade controls, a 2001 study determined that: "Few governments initiate sanctions against other regime members to enforce export controls; however, most governments have more restrictive procedures for licensing exports to countries with weak export controls and a poor nonproliferation record. In the mid-1980s, for example, changes in section 5(k) of its Export Administration Act allowed the United States to provide special licensing benefits for exports to countries with complementary export control systems, even if those countries were not in COCOM." Richard Cupitt, Suzette Grillot, and Yuzo Muryama, "The Determinants of Nonproliferation Export Controls: A Membership-Fee Explanation," *The Nonproliferation Review*, Summer 2001. A study of why many post-Soviet republics adopted trade controls supported the notion of technology transfer benefits. See, Gary Bertsch and Suzette Grillot, eds., *Arms on the Market: Reducing the Risk of Proliferation in the Former Soviet Union* (New York: Routledge, 1998).

Italian economy (Marchionatti and Usai 1998).[46] The effect of technology transfer on imitation and growth is even stronger for less developed economies (cf. Conolly 2003, p. 20). There, the impact of imported foreign technology on domestic economic growth has been found to be deeper than that of domestic technology (Schneider 2005). For instance, in a study of Indonesian manufacturers, Blalock and Veloso (2007) demonstrate at the level of individual firms that technology transfer through technology imports led to significant productivity gains. In that case, firms who were able to receive more imports of technology goods used these transfers to learn and adapt their production, to increase productivity, and thus to grow faster.

3. Structure of the Study

This study engages the competing perspectives on the potential advantages and suboptimal effects of trade controls to evaluate the impact of strategic trade control system development on national economies. As the most direct indicator, we examine the development of trade flows in advanced technology products before and after a sample of 14 countries introduced comprehensive strategic trade controls legislation.[47] The causal chain from controls over trade flows to overall production and revenue from economic sectors is an indirect one, and can hardly be directly observed. To approximate this relationship, we consider imports *and* exports of high-technology goods separately. In the previous section, we report that a number of studies have found a positive long-term relationship between technology transfers from highly industrialized economies to the type of countries that are of interest to this study. Therefore, we examine the development of imports of high technology goods to the countries of interest as one part of the relationship between trade controls and economic development. Second, the direct concerns voiced from industrializing economies are about the stifling impact of trade controls on their ability to export technology items that would compete with higher cost products from high-wage economies. We address the implications of this argument by tracing the actual exports from our countries of interest before and after they introduced strategic trade control systems.

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[46] In the various critiques of export controls, most notably of the export control regime, developing countries have argued that supply-side controls limit their ability to import high-tech products that will facilitate economic growth. See, for example, Stanley Foundation and Stimson Center, "Improving Multilateral Export Controls and Technology Access for the Developing World," *Event Summary*, December 2002, *Washington, DC* <http://www.stimson.org/exportcontrol/pdf/December12summary.pdf>.

[47] Clearly, in terms of trade flows, we are not concerned with overall trade (i.e., aggregate balance of trade) or trade in non-strategic items. There is no discernible logic or evidence for any substantial relationship between overall trade and strategic trade controls. Only a marginal share of goods traded between countries – a subset of the ATP categories described in this study – is affected by the strategic trade control licensing process.

4. Strategic Trade Control Systems and Trade Volumes

If trade controls have any discernible effect on economies as a whole, it should be visible in the contraction or expansion of trade flows. This section examines the development of exports and imports from selected countries that introduced strategic trade control measures.

4.1 Detrimental Effects of Strategic trade controls

Both arguments about the benefits and disadvantages of adopting strategic trade controls implicitly incorporate a developed economies perspective. In the first argument, advanced economies attempt to deny technology goods to potential competitors to shield their own markets through what amounts to non-tariff barriers (NTBs).[48] They also attempt to impose further hurdles for the export of technology goods in order to increase the overall cost of potentially competitive high technology goods, thereby protecting domestic producers. The observable implication of this behavior would be a decline in the trade of relevant goods between these countries due to the added obstacles accruing from the developing countries' strategic trade control system:

> ***Hypothesis 1****:* When countries introduce comprehensive export control systems, they regularly experience a decline in exports and imports of technology products, holding all else constant.

4.2 How Strategic trade controls Can Facilitate Trade

The second argument highlights the decisions supplier states make about those states with which they can (and should) trade. Better strategic trade control systems in other countries significantly reduce the risk that dual-use technology and goods will be diverted to undesirable (and unlicensed) destinations. Therefore, it is likely that particularly those countries with comprehensive trade control systems (such as the United States and EU member states) grant more licenses for goods to destinations that have implemented strategic trade control systems. Consequently, with more licenses granted, one would expect that trade in relevant goods between these sets of countries is, at a minimum, not negatively affected when these countries begin to implement strategic trade control systems.

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[48] Liam Anderson and Jyotika Saksena, "Explaining Variation in the Use of NTBs in Developed Countries: The Role of Political Institutions," *International Politics*, Vol. 45, (2008), pp. 475–496.

Hypothesis 2: When countries introduce comprehensive export control systems, they do not experience any significant change in exports and imports of technology products, holding all else constant.

4.3 Benchmarking Strategic Trade Control Development

We have chosen the year in which comprehensive strategic trade controls legislation was enacted as the benchmark date for strategic trade control system adoption. The Center for International Trade and Security at The University of Georgia has developed very detailed metrics with which one can ascertain a government's level of strategic trade control system development. However, we have opted instead – for reasons of simplicity and the absence of a consensus definition of what constitutes necessary and sufficient minimal criteria for a "system" – to use the adoption of national legislation specifically enacted to control the transfer of dual-use items and technologies to indicate when a country put a system in place.[49] The enactment of specific dual-use trade control legislation, even if imperfectly implemented, represents a government's explicit strategic trade control commitments and necessarily creates a regulatory atmosphere of compliance for the exporting community.[50]

4.4 Measuring Trade Flows

The trade flows central to these arguments are best described as encompassing high technology goods. Because strategic trade controls target dual-use materials that can be

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[49] As a further qualification on our use of national dual-use export control law as the export control benchmark against which we plotted economic impact, we based on our selection of national laws to the extent they conformed with "international best practices," as identified in *Legal Authorities for an Effective Export Control System***.** While some countries have various trade related laws officials claim approximate dedicated legislation (e.g., Thailand), explicit legislation removes otherwise ambiguous control provisions exporters or proliferants could exploit and represents an official recognition of export controls as a singular policy issue. See, <http://exportcontrol.org/library/2062/Model_Template_for_Legal_Authorities_for_an_Effective_Export_Control_System.pdf>.

[50] The legal base of a strategic trade control system is also an explicit requirement of UN Security Council Resolution 1540, which requires that all states shall "establish, develop, review and maintain appropriate effective national export and trans-shipment controls over such items, including appropriate laws and regulations to control export, transit, trans-shipment and re-export and controls on providing funds and services related to such export and trans-shipment such as financing, and transporting that would contribute to proliferation, as well as establishing end-user controls; and establishing and enforcing appropriate criminal or civil penalties for violations of such export control laws and regulations." UN Security Council Resolution 1540, 20 April 2004, §3d.

employed for the construction of weapons of mass destruction or advanced conventional military items, many related technology items that are critical to civilian industries are also subject to these regulations. Such items are, at the same time, important carriers of the technology transfer conducive to economic growth (see Section 2).[51]

Any study of the link between strategic trade controls and trade flows must carefully choose the instrument by which to measure trade flows for which one can reasonably expect a relationship with strategic trade controls regulations. Because one goal is to provide a meaningful assessment of technology transfer, the instrument needs to include a broad enough share of technology items traded between two countries in a given year. At the same time, the measure must also be narrow enough to ensure a plausibly valid correspondence between general high technology and specific dual-use categories.[52] The items under consideration must also be subject to strategic trade controls regulations in order to make the case for a traceable relationship between export licensing procedures and actually occurring trade. Thus, the goods included in the instrument should exhibit a substantial number of the characteristics that qualify dual-use goods; i.e. they should be those types of goods that are potentially required to pass the export licensing process. For instance, while soy beans are not affected by any strategic trade controls because they are not dual-use goods, one can easily make the case that exporters of microchips might have to clear more bureaucratic hurdles within a functioning strategic trade control system.

4.5 Advanced Technology Products (ATP)

The existing categorization of "Advanced Technology Products" provided by the United States Census Bureau meets these criteria. ATP statistics were first generated in the late 1980s and early 1990s in order to establish an appropriate and accurate measurement of high technology trade, which had been unavailable prior to that point (Abbott et al. 1989; Abbott 1991). The existing trade classifications, the Harmonized Classification System (HS) and the Standard International Trade Classification (SITC) as well as national classification structures, are structured in a way that complicates the extraction of high-

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[51] In a 2004 study, Amitav Mallik noted: "Increasingly, [dual-use] technology is being developed largely by civilian sector enterprises and multinational companies that cut across the globe and work primarily for economic development and commercial benefits." Amitav Mallik, *Technology and Security in the 21st Century: A Demand-Side Perspective* (Stockholm: By, Stockholm International Peace Research Institute, 2004), p. 19

[52] A practical statistical justification for this approach concerns the fact that there are significant data availability issues pertaining to global dual-use trade. Dual-use item classifications change frequently with technical development. This includes changes in the corresponding customs classification codes (see fn. 52 for more detail). Furthermore, in some cases, the volume of trade in control list-based dual-use items between select countries would be minuscule, such that drawing inferences about an impact on a country's economy would be both impractical and methodologically suspect.

technology trade data.[53] These schemes employ categories that branch out deeply in detailed classifications for tariff purposes, but their top-level domains often contain both high- and low-technology products. In particular, this can be the case when these domains comprise high-tech goods as well as the low-tech goods produced with the high-tech machinery (Abbott 1991, p. 24).

Relying on existing categories that comprise both low- and high-technology goods can thus significantly distort observations and interpretations of advanced technology trade flows and transfer. ATP data, on the other hand, contains exclusively high technology goods (see Appendix 3 for ATP categorizations). A number of these goods are also represented on the United States' and European Union's control lists for dual-use items.[54]

4.6 Obtaining Data on Advanced Technology Trade

This study uses the ATP categorization to generate a dataset of advanced technology trade between the two entities with comprehensive strategic trade control systems, the United States and the core of the European Union, and a number of partner countries

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[53] Most countries use as their basic classification either the UN Harmonized System (HS) or a classification based on the HS. The Member States of the EU use the "Combined nomenclature" (which is the language of the EU Dual-Use control list) which is an extension of the HS; the United States' basic classification is the Commerce Department's "Schedule B" which can also be linked to the HS. The Standard International Trade Classification (SITC) classifies goods broadly according to their stage of processing and is considerably less detailed than the HS.

[54] There are no precise means to match HS codes with control list alpha-numerics. The EU has developed an unofficial correlation table. With its release in 2004, the Commission emphasized the informal nature of the table: "The Commission is well aware of the limits of the correlation table given that TARIC and Annex I (i.e., dual-use control list) to Regulation no. 1504/2004 follow a different logic because the legal acts which they are based on aim at different purposes. However, despite these above mentioned limits, the correlation table has been established as a working tool for frontline customs officers to enable them to see quickly whether a certain product could be covered by Annex I to Regulation 1504/2004. A given TARIC code under normal circumstances covers a wider range of products than those which are included in Annex I to Regulation no. 1504/2004. Therefore the fact that the TARIC code of a certain product appears in the correlation table does not necessarily mean that this product is included in Annex I to Regulation no. 1504/2004. On the other hand a product which is included in Annex I to Regulation no. 1504/2004 can be covered by more than one TARIC code or even not all covered by TARIC. From DG TAXUD's point of view it does not seem to be possible to adapt the TARIC in a way that it corresponds perfectly with Annex I to Regulation no. 1334/2000." See, Note for the Attention of the Working Party on Dual-Use Goods, "Proposal to the WP on Dual Use: Taxud Correlation Table," DS 54/1/2004 REV 1, Brussels, 5 November 2004 <*www.sojuzkomori.org.mk/Uploads/Korelaciona%20tabela-en04.doc*>. Likewise, a 2006 GAO study noted the complexities involved in capturing dual-use export data accruing the differing coding systems. See, General Accountability Office (GAO), *Analysis of Data for Exports Regulated by the Department of Commerce*, GAO-07-197R, 13 November 2006.

on the other hand. The "core" of the EU is here identified as the EU-15.[55] To ensure comparability across time for this longitudinal study, we focus on this core of EU states rather than all current Member States. The newest members in particular had not adjusted their strategic trade control systems to EU standards before they joined (Jones, 2003), and thus do not allow for similarly examining the impact of strategic trade controls.

The United States and the EU-15 have developed strategic trade control systems *and* are directly affected when less developed states become competitors through employing high-technology goods for production. Consequently, the United States and the EU-15 are the most likely cases to employ either strategy: they might employ strategic trade controls as hidden non-tariff barriers; and they would be the main actors to utilize a licensing process that is based on a rigorous evaluation of partner countries' strategic trade control system and nonproliferation commitments (Fuhrmann, 2008).

To obtain these data, we use the list of ATP definitions (U.S. Census 2008) in order to generate queries from two major trade databases. We translate this list into HS-6 codes, which is the most specified level of item codes that is jointly used by U.S. and EU trade databases. This transformation yields 219 individual HS-6 codes (commodities, or commodity categories) that qualify as advanced technology products. The list of these items (item groups) then is the input for extracting aggregate trade data. For trade flows between the U.S. and partner countries, we use the U.S. International Trade Commission database (USITC) and extract trade data for all available years 1996-2008. For trade flows between the EU and partner countries, the Comtrade database from the EU Statistics Bureau provides the corresponding data for the years 1995-2008. The U.S. and EU databases provide data that is extractable by HS-codes since the years 1995/1996, which thus sets the downward time limit of this study.

It must be noted that only a sub-sample of the 219 HS-6 codes are actually controlled dual-use goods on the basis of the EU control list. This sub-sample is listed in Table 1 for illustrative purposes. In the analysis below, we use the aggregate volume of exports/imports of all 219 HS-6 commodity codes that qualify as advanced technology products. This strategy is chosen to minimize the trade-off between an exact measure for controlled goods on the one hand and the assumption of a link between trade in specific goods and economic structure and performance on the other. Because only a fraction of dual-use goods is listed in the commonly used ATP definitions, restricting the variable of interest to this selection would render any assumed impact of this trade

[55] The EU15 is comprised of the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom. In comparison to the other 13 Member State, the EU-15 also represent the countries with the most experience in implementing export controls.

volume on the economy marginal. Conversely, the European Union's dual-use control list and correlation table of goods and HS-6 commodity codes contains 3,189 individual goods.[56]

Table 1. ECCN-HS Correlation in ATP Data

ATP Category	HS	ECCN	Commodity Description
Life Sciences	9022120000	1B001e	COMPUTED TOMOGRAPHY APPARATUS
	9022190000	1B001e	APPARATUS BASE ON X-RAY FOR OTH USE,EX MEDICAL,ETC
	9024900000	9A010c	PTS, MACHINE & APPLN, TEST HARDNESS/STRENGTH, ETC
Opto-Electronics	8471608000	9A116d	OPTICAL SCANNERS & MAGNETIC INK RECOGNITION DEVICE
	9013200000	6A205	LASERS, OTHER THAN LASER DIODES
	9031410000	5B002	OPTICAL INST FOR INSPECTING SEMICONDUCTOR WAFERS
Information & Communications	8471490000	9A116d	DGTL ADP, NOT IN HOUS W/ CPU OR IN/OUTPT DVC,NESOI
	8471702000	4A001	MAGNETIC DISK DRIVE UNITS GT 21 CM(83 IN) IN DIAM
	8471703000	4A001	MAGNETIC DISK DR UNIT,DISK DIAM GT 21CM,NESOI
	8471900000	9A116d	MACHINES AND UNITS THEREOF FOR PROCESS DATA, NESOI
	8526920000	7A117	RADIO REMOTE CONTROL APPARATUS
	8803903000	9A120	PARTS OF COMMUNICATIONS SATELLITES
Electronics	8540790000	3A001b	MICROWAVE TUBES, NESOI
	8543200000	3A002d	SIGNAL GENERATORS
Flexible Manufacturing	8459100000	2B201a	WAY-TYPE UNIT HEAD MACHINES
	8479500000	2B207	INDUSTRIAL ROBOTS, NESOI
	8515310000	0B005	ELECTRIC WELDERS, ARC, FULL OR PARTLY AUTOMATIC
	9030400000	3A002e	OTH INST, SPECIALLY DESIGNED FOR TELECOMMUNICATION
	9030820000	3B002	INST & APP FOR MEAS/CHECK SEMICOND WAFERS/DEVICES
Advanced Materials	8544700000	5A001c	INSULATED OPTICAL FIBER CABLES WITH INDVULY SH FBR
Nuclear Tech	8401100000	0A001a	NUCLEAR REACTORS
	8401200000	1B233b	ISOTOPIC SEPARATION MACHINERY, APPARATUS AND PARTS
	8401300000	0C002	FUEL ELEMENTS (CARTRIDGES)NON-IRRADIATED, AND PART
	8401400000	0A001b	PARTS OF NUCLEAR REACTORS
	9030100000	1A004c	INST FOR MEASURING/DETECTING IONIZING RADIATIONS

Aside from technical problems with extracting aggregate trade volumes for a group of goods this large, we also argue that analyzing ATP has two advantages over any construction of HS-6 equivalents to the EU control list. First, the control list is not a fixed document. Items are added and removed frequently. Thus, the dependent variable of this study would vary based on these changes, and thus render itself unusable for any time-series examination.[57, 58] Second, we believe that ATP trade in general better

[56] The correlation matrix can be found at < http://trade.ec.europa.eu/doclib/docs/2006/december/tradoc_131339.pdf>.

[57] To emphasize this problem, imagine that two product categories are added to the EU control list on January 1, 2006. If one were to compare trade flows of all controlled goods between the years 2005 and 2006, one would observe an increase in this volume in 2006 – but this increase would not reflect

captures actually occurring trade in goods that are relevant for dual-use trade. Especially in countries that newly introduced strategic trade control systems, it is reasonable to assume that many actual or potential dual-use items will not be listed in trade statistics under the HS-6 code that corresponds to the EU dual-use control list or that they do not produce and/or export statistically significant quantities of dual-use goods. Aggregate ATP trade thus provides the best compromise of a measure on measurable and interpretable aggregate trade that is large enough to affect a country's economy sectorally and in general.

4.7 Case Selection

Based on previous work conducted by the Center for International Trade and Security at The University of Georgia and on the parameters detailed in the study requirements, we identified all relevant countries that had introduced comprehensive strategic trade control laws during the time span for which ATP trade data are available.[59] We then selected all relevant countries for which we could obtain data for at least one year before and after the year in which the strategic trade controls legislation was implemented. The eventual selection creates a sample of 14 countries: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, India, Israel, Kyrgyzstan, Moldova, Pakistan, Singapore, Ukraine, and Uzbekistan.[60] All other countries introduced strategic trade control legislation too early or too late within the data frame to draw any inferences. For example, Brazil has had a comprehensive strategic trade control law since 1992. Because the data on ATP trade are only available since 1995, no trend can

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any substantial growth in trade; it would merely be an artifact of the changes in the criteria for the trade flows examined. This could, for instance, lead to an artificial result of the type where export controls increase trade flows – but not because trade increased, rather because the number of goods that are taken into consideration was expanded.

[58] This instability in product classifications and HS-6 codes is also reflected by the volatility of correspondence tables between controlled goods and HS-6 codes. For instance, this is reflected in the concordance list for controlled goods provided by the Customs office of the government of Singapore, which cautions the reader: "*Please note that the control is based on the actual product description and technical specifications, and not by the HS Codes. The HS Codes are provided for reference only and may be subject to changes from time to time. Traders are advised to refer to the Strategic Goods (Control) Order for up-to-date information in relation to the definitions and scope of goods subject to controls."* See online at <http://www.customs.gov.sg/NR/rdonlyres/74516473-349A-4888-98B5-9D0B176B2D55/0/HSConcordanceJan08.pdf>

[59] On behalf of the Bureau of International Security and Nonproliferation, Office of Export Control Cooperation of the U.S. Department of State, CITS/UGA has conducted export control evaluations of over 60 countries.

[60] We should note that some of the cases – Belarus, Bulgaria, and Ukraine – are, respectively, members of the Nuclear Suppliers Group (Belarus) and all four of the multilateral export control arrangements. Ideally, we would confine the study to non-regime members, per the study recommendations. However, these three cases were instance where extensive economic data was readily available and instanced the enactment of a specific export control law.

be assessed that can compare trade before and after the introduction of the law in 1992. Table 2 summarizes the economic structure of these countries with regard to external trade.

Table 2. Case Selection Summary Trade and Macroeconomic Data

						Rank in World Trade		Breakdown in economy's total exports		
	Trade to GDP ratio (2005-2007)	Trade per capita (US$, 2005-2007)	GDP (million current PPP US$, 2007)	Share in world total exports (%)	Share in world total imports (%)	Export	Import	Agricultural	Fuels & Mining	Manufactures
Albania	67.1	1 979.0	20 312.5	0.01	0.03	143	111	7.3%	19.5%	71.7%
Armenia	62.9	1 426.0	17 139.0	0.01	0.02	140	125	17.0%	24.9%	54.0%
Azerbaijan	105.3	2 710.0	64 082.0	0.15	0.04	65	100	5.2%	90.5%	3.7%
Belarus	125.0	4 789.0	105 264.0	0.17	0.20	62	59	9.2%	35.6%	53.0%
Bulgaria	144.0	6 141.0	86 339.0	0.13	0.21	67	57	10.4%	32.6%	56.0%
Croatia	106.1	10 595.0	68 861.0	0.09	0.18	76	62	14.0%	17.5%	68.1%
India	44.9	391.0	3 092 126.0	1.05	1.52	26	18	11.0%	24.3%	63.6%
Israel	88.0	18 113.0	185 883.0	0.39	0.41	46	44	4.2%	1.9%	93.7%
Kyrgyzstan	125.5	707.0	10 382.0	0.01	0.02	142	139	17.8%	28.7%	31.8%
Moldova	139.7	1 311.0	9 707.0	0.01	0.03	134	115	38.6%	6.0%	55.4%
Pakistan	41.6	331.0	409 973.0	0.13	0.23	68	53	13.0%	6.7%	80.1%
Singapore	447.0	140 848.0	230 824.0	2.14	1.84	14	15	2.0%	15.5%	75.9%
Ukraine	97.0	2 313.0	320 762.0	0.35	0.42	49	42	13.8%	11.4%	73.6%
Uzbekistan	65.1	439.0	65 167.0	0.06	0.03	85	108	NA	NA	NA

(source: World Trade Organization, 2009)

4.8 Tracking High-Technology Trade Flows, 1995/96-2008

A. Graphs

First, we graphically track the univariate development of trade flows with selected countries in relation to their progress in developing comprehensive strategic trade controls legislation. The graphs are displayed in the appendix individually for each country in the sample. We find no clear, consistent decrease in ATP imports or exports after states introduced strategic trade controls laws. Figures X through Y all show the volume of exports from selected countries to the United States and to the EU-15 (upper panels), and imports from the United States and EU-15 to these countries (lower panels). Across all cases, it is clearly discernible that ATP trade flows are quite volatile. This is particularly visible for those countries whose ATP trade volumes are rather small, compared to high-volume technology trade partners such as India. Regardless, the limited trends that one can observe from the graphs provide no strong indication for a suppressive effect of strategic trade controls on trade. In every graph, the vertical line in the middle of the time series marks the year in which the respective country introduced strategic trade controls legislation. In all but two cases, ATP imports appear to be higher on average after this measuring point. In only one case, we observe a lower level of ATP exports from a country in the sample after controls were introduced. In this particular instance, Singapore, we have reason to believe that this trend can be linked to shifts in the production markets for high technology goods in the region.[61]

B. Estimations of Panel Data High-Technology Trade

While the graphs above show the univariate development of trade flows in consideration of the status of strategic trade control systems, in reality trade fluctuates over time for a multitude of reasons. Therefore, we present a fixed-effects estimation[62] of high-technology trade flows for individual countries over time. These statistical models take into account a set of factors that can be conceptually related to trade in

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[61] See, for example, Toshihiro Okubo, "Intra-industry Trade, Reconsidered: The Role of Technology Transfer and Foreign Direct Investment," *The World Economy*, Vol. 30, No. 12 (December 2007); and Young-Han Kim, "Impacts of Regional Economic Integration on Industrial Relocation through FDI in East Asia," *Journal of Policy Modeling*, Vol. 29, No. 1 (January 2007). See also, fn. 18.

[62] Fixed effects estimation is a method of estimating parameters from a panel data (i.e., two-dimensional data) set. The fixed effects estimator is obtained by OLS on the deviations from the means of each unit or time period. This approach is relevant when one expects that the averages of the dependent variable will be different for each cross-section unit, or each time period, but the variance of the errors will not.

advanced technology products in particular, and they allow for unexplored characteristics in each of the cases observed. With each model, we track the relationship of these factors and the development of ATP trade *within* one country over time, that is, three years before and after the strategic trade controls legislation was introduced.[63] Without a readily available, comprehensive theory of the determinants of ATP trade across nations, this study restricts itself to comparisons of these trade flows within countries.[64]

We assume a number of factors to be potentially related to the value of advanced technology products that an economy exports and imports:

- *Size of the economy*. Since larger economies produce higher outputs, one might expect a relationship between absolute economic growth and ATP trade flows. This variable, operationalized as GDP, is taken from the World Development Indicators database.
- *Economic wealth*. Wealthier economies may be expected to have a more qualified labor force, which may signal their ability to mass-produce high technology goods. We measure wealth as GDP per capita, taken from the World Development Indicators database.
- *Population size*. Larger countries often attract more trade due to larger markets. These data are also taken from the World Development Indicators database.[65]
- *Industrial production*. With this variable, the share of industrial production of the overall output of the economy (GDP), we attempt to capture an economy's ability to produce advanced technology goods. This ability can condition actual

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[63] Given the constraints imposed by the present case selection, we are unable to plot the time-series beyond three years before and after controls, as doing otherwise would introduce inconsistencies in measuring effects and produce incorrect estimations. To be sure, we also examined several alternative specifications, expanding the time before and after the strategic trade controls were introduced to 5 and 7 years. All these estimations returned identical results: the presence of a strategic trade control law had no relationship with the development of ATP trade.

[64] We do not present a gravity model of international trade. Gravity models estimate the volume of trade between countries based on factors such as production, consumption, distance, tariffs, and others. This study is concerned with a particularized form of trade that is sensitive to different factors than the determinants of overall trade. We thus have neither the theoretical nor empirical justification for reliably predicting counterfactual trade through a gravity model. To provide useable empirical results, gravity models must account for demand or consumption in the economies to be examined. Gravity models of overall trade do so by using the size of an economy as a proxy. Since this study examines specific, sectoral trade, the lack of a reliable proxy for ATP demand and consumption does not allow for this type of estimation. For gravity model application guidelines, see, for example, Edward Balistreri and Russell Hillberry, "The Gravity Model: An Illustration of Structural Estimation as Calibration," *Economic Inquiry*, Vol. 46, No. 4, October 2008, pp. 511–527.

[65] World Bank, *World Development Indicators, 2009* < http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:21725423~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>.

occurring exports and imports. These data are again taken from the World Development Indicators database.

- *Foreign direct investment*. We also control for changes in the volume of foreign direct investment (FDI). FDI may affect the demand for high-technology products for industrial facilities, and it may also be the background condition for facilities that produce goods than can then be exported. These data are also drawn from the World Development Indicators database.
- *ATP trade in the previous year.* Following standard econometric practice, we also present each model adding a lagged dependent variable, the volume of ATP imports/exports in the previous year.

A dummy variable for strategic trade control systems is then used to denote the years in which the country has comprehensive strategic trade controls legislation in place. Typically, the models consider ATP trade volumes three years before and after the strategic trade control system was introduced.

This specification corresponds to the following equations for fixed-effects (FE) time-series regression. The FE estimation is the most appropriate technique to statistically examine the question of this study. FE models estimate the relationship of the specified explanatory variables with an outcome – ATP trade flows – that varies over time.[66] The value of ATP trade in one given year is clearly related to its value in the previous year; accounting for this relationship in the FE models provides for optimized estimation. In addition, these models allow for unit-specific variation that is not captured by the specified explanatory variables. For instance, there might be a quality inherent to one country that is not captured by the variables included in the model. If this quality is missing from the model, the results can be biased. One example would be historic trade ties of a country with the United States – a factor that was not introduced in the model. FE models contain a variable for every country in the sample that covers these unobserved, country-specific factors and thus alleviates the bias from potential omitted variables.

In the equations below, the *i*-subscript indexes the individual countries, and the *t*-subscript captures the time points (years). The fixed effects model uses a country-specific intercept, α_i. This intercept α_i denotes the baseline level of the outcome variable (ATP imports or exports) from which the size of the relationship with the explanatory variables is calculated through the ß-coefficients. The intercept, then, is the "fixed effect" for each of the countries in the sample. The ß-coefficients are reported in tables 3 through 6 in Appendix 1.

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[66] See, P.D. Allison, *Fixed Effects Regression Methods for Longitudinal Data Using SAS,* (Cary, NC: SAS Publishing, 2005).

For exports coming out of partner countries to the United States or the EU-15, we estimate:

$$\ln(Exports)_{it} = \alpha_i + \beta_1 XC_{it} + \beta_2 \ln(Exports)_{i(t-1)} + \beta_3 \ln(GDP)_{it} + \beta_4 \ln(GDP\,p.c.)_{it} + \beta_5 \ln(Population)_{it} + \beta_6 (Industry/GDP)_{it} + \beta_7 \ln(FDI)_{it} + \varepsilon_{it} \quad [1]$$

and for the volume of goods that partner countries imported from the U.S. and the EU-15 respectively, we estimate:

$$\ln(Imports)_{it} = \alpha_i + \beta_1 XC_{it} + \beta_2 \ln(Imports)_{i(t-1)} + \beta_3 \ln(GDP)_{it} + \beta_4 \ln(GDP\ p.c.)_{it} + \beta_5 \ln(Population)_{it} + \beta_6 (Industry/GDP)_{it} + \beta_7 \ln(FDI)_{it} + \varepsilon_{it} \quad [2]$$

C. Results

In the tables below, we show the estimation results for export and import flows for the United States and the EU-15 separately. Each model contains an equal number of observations (years) for each country before and after the strategic trade control system was introduced. The coefficients for each model are based on fixed-effects models of trade flows. Consistent with the arguments laid out above, this estimator takes into account the variation in trade flows *within* the countries in the sample over the observed time period. A negative, significant coefficient would thus express a negative relationship between the introduction of strategic trade controls and the development of ATP trade.

In the data analysis performed for this study, strategic trade controls legislation nowhere exerts a negative, statistically significant influence on the volume of exports or imports. With confidence, we therefore reject the first hypothesis about a negative impact of strategic trade controls on trade relationships. In this sample of 14 countries, ATP trade of these countries with the United States and the EU-15 did not decrease on average after these countries introduced strategic trade controls legislation between 1997 and 2005.[67] A second interesting finding is displayed in Table 4, which presents the results for imports from the EU-15. On average, having an strategic trade controls law increased, at a statistically significant level, the volume of Advanced Technology Products imported by the partner countries from the EU-15. This is surprising, since the potential cause of positive effects of comprehensive strategic trade control systems on

[67] GDP, GDP per capita, and the population were means-centered due to potential multicollinearity. The natural log of these three variables and FDI were used in each of the models; the dependent variable, imports/exports from/to the U.S./EU-15 was logged as well. Alternative model specifications that used only GDP per capita as economic indicator produced substantially identical results, as did models that excluded the technology-specific variables of industrial production and FDI.

ATP trade is based on a sequence of indirect effects. Essentially, we would identify this positive causal effect as based on increased exporting activity from the EU-15 to the partner country due to a higher number of licenses granted to EU-15 based exporters with regards to the respective partner country. If strategic trade control systems in partner countries actually were to increase the exports from the EU-15 (or the U.S.), it would be through the licensing process in the exporting countries. In other words:

- if EU-15 countries grant more export licenses due to the presence of a strategic trade control in the partner country, and
- if the demand for high-technology goods is given in the partner country, but was hindered by the denial of licenses before trade controls were introduced,
- then an increase in actually occurring high-technology exports to the partner country can be related to the introduction of strategic trade controls in this country.

Overall, the empirical evidence of actually occurring trade in advanced technology products in the available sample of countries consistently demonstrates that trade was not negatively impacted by the enactment of strategic trade controls legislation. This finding is robust in the univariate development of ATP trade and using several specifications with potential predictors of ATP import/export volumes.

7. Conclusion

This study examined imports and exports of advanced technology products as a means to assess any discernible impact of strategic trade controls on overall economic development. Because strategic trade controls regulate the trade of dual-use materials, any economic actors and processes that are related to advanced technology products are potentially affected by their introduction. Dual-use items overwhelmingly fall under this category, and any direct or indirect costs may have an impact on producers of high-technology goods in general as they may, for instance, face the complexities of the licensing process. On the other hand, previous econometric studies contend that trade in advanced technology goods in both directions (imports and exports) as one of the mid- and long-term pillars of economic growth, particularly for newly industrialized economies and frontier markets such as most of the countries in this study's sample. Based on economic research, any impact of strategic trade controls on the general economy should thus be channeled through their relationship with trade in these categories. The findings of this study robustly reject any stifling effect of trade controls on exports or imports of high-technology trade within the group of countries for which data could be obtained.

Despite the robust findings evidenced in these cases, however, it would be imprudent to extrapolate a larger theory of economic impact and strategic trade controls given the limited sample number and the exclusion of other variables.[68] Nevertheless, this study supports earlier empirical analyses assessing the relative economic impact of trade controls; namely: strategic trade controls harm neither a country's ability to import or export advanced technology items. In this and other studies, it is clear that the level of economic development is a key explanatory variable. Countries relatively new to strategic trade controls are generally not major suppliers of dual-use or advanced technology. It would follow that the relevant controls would not affect exports. As developing economies, moreover, strategic trade controls development may explain in part why imports of advanced technology items are either unaffected or increase after the adoption of controls (e.g., in the form of end-user provisions).

These findings have important policy implications as well. Minimizing the proliferation threat is a key component of U.S. national security and foreign policies. Assisting countries in the adoption of strategic trade controls is a critical aspect of the overall nonproliferation effort. To the extent that Washington can arrest concerns regarding the adoption of controls by invalidating anecdotal claims about the economic impact of adopting controls with empirical data, the likelihood of successful strategic trade controls cooperation is likewise enhanced. In this regard, we should also note that, in addition to providing rigorous counterclaims, earlier UGA/CITS research suggests that U.S.-mediated strategic trade controls assistance is enhanced through sustained financial support and political engagement.[69]

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[68] Other variables would include, for example, WMD possession or known acquisition efforts, the level and type of disputes between trade partners, government type, common membership in regional trade agreements, customs unions, free trade agreements, and export control arrangements. Fuhrmann (2007) found that the existence a strategic alliance with the U.S. and "joint democracy" were very strong predictors of U.S. licensed dual-use exports. See also, Andrew Long, "Defense Pacts and International Trade," *Journal of Peace Research*, Vol. 40, No. 5, 2003, pp. 537–552.

[69] See, Gary Bertsch and Suzette Grillot, eds., *Arms on the Market: Reducing the Risk of Proliferation in the Former Soviet Union* (New York: Routledge, 1998).

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Appendix 1: Fixed-Effects Regression Tables

Table 3: Fixed-effects regression of exports to the United States

	(1)	(2)
Strategic trade control law	0.432	0.198
	(0.488)	(0.366)
Exports to the U.S. (lagged)		-0.447**
		(0.153)
GDP (logged)	-24.07	-27.09
	(47.95)	(35.05)
GDP per capita (logged)	22.62	26.88
	(47.87)	(35.04)
Population (logged)	29.06	34.61
	(49.31)	(36.31)
Industry, value added (% of GDP)	0.120	0.0635
	(0.0814)	(0.0761)
FDI (lagged)	-0.499	-0.534*
	(0.250)	(0.229)
Constant	-58.61	-103.0
	(134.1)	(102.3)
Observations	56	49
R^2	0.181	0.291
Countries	13	11

Standard errors in parentheses. ** p<0.01, * p<0.05.

Table 4: Fixed-effects regression of imports from the United States

	(1)	(2)
Strategic trade control law	-0.112	0.387
	(0.551)	(0.604)
Imports from the U.S. (lagged)		-0.137
		(0.161)
GDP (logged)	-11.72	-38.86
	(59.06)	(59.71)
GDP per capita (logged)	14.31	40.93
	(59.02)	(59.60)
Population (logged)	18.82	48.01
	(60.63)	(61.43)
Industry, value added (% of GDP)	-0.0586	-0.0782
	(0.0758)	(0.0757)
FDI (lagged)	-0.104	-0.230
	(0.271)	(0.276)
Constant	-121.0	-147.3
	(152.7)	(151.5)
Observations	63	61
R^2	0.041	0.088
Countries	13	13

Standard errors in parentheses.

Table 5: Fixed-effects regression of exports to the EU-15

	(1)	(2)
Strategic trade control law	0.366	0.0475
	(0.544)	(0.554)
Exports to the EU-15 (lagged)		0.0839
		(0.192)
GDP (logged)	-34.45	-20.38
	(60.02)	(55.75)
GDP per capita (logged)	39.03	25.10
	(59.93)	(55.60)
Population (logged)	20.02	8.844
	(61.55)	(57.31)
Industry, value added (% of GDP)	0.0483	0.0668
	(0.0755)	(0.0707)
FDI (lagged)	-0.225	-0.144
	(0.246)	(0.246)
Constant	219.5	168.1
	(152.0)	(143.2)
Observations	67	64
R^2	0.311	0.364
Countries	14	14

Standard errors in parentheses.

Table 6: Fixed-effects regression of imports from the EU-15

	(1)	(2)
Strategic trade control law	0.488**	0.432*
	(0.160)	(0.171)
Exports to the EU-15 (lagged)		0.203
		(0.173)
GDP (logged)	-22.83	-18.18
	(17.94)	(18.12)
GDP per capita (logged)	24.14	19.10
	(17.93)	(18.09)
Population (logged)	24.63	18.36
	(18.37)	(18.61)
Industry, value added (% of GDP)	0.00476	0.0137
	(0.0219)	(0.0230)
FDI (lagged)	0.00887	0.0333
	(0.0739)	(0.0800)
Constant	-27.69	-1.322
	(45.43)	(48.97)
Observations	68	65
R^2	0.618	0.639
Countries	14	14

Standard errors in parentheses. ** p<0.01, * p<0.05

Appendix 2

Table Graphs

Appendix 3: ATP Breakdown by Categories

Category	Definition
Biotechnology	Focuses on medical and industrial applications of advanced scientific discoveries in genetics to the creation of new drugs, hormones and other therapeutic items for both agricultural and human use.
Life Science	Concentrates on the application of scientific advances (other than biological) to medical science. Recent advances, such as nuclear resonance imaging, echocardiography, and novel chemistry, coupled with new production techniques for the manufacture of drugs have led to many new products for the control or eradication of disease.
Opto-Electronics	Encompasses electronic products and components that involve the emitting and/or detection of light. Examples of products included are optical scanners, optical disc players, solar cells, photo-sensitive semiconductors and laser printers.
Information & Communications	Focuses on products that are able to process increased volumes of information in shorter periods of time. Includes central processing units, all computers and some peripheral units such as disk drive units and control units, along with modems, facsimile machines and telephonic switching apparatus. Examples of other products included are radar apparatus and communication satellites.
Electronics	Concentrates on recent design advances in electronic components (with the exception of opto-electronic components) that result in improved performance and capacity and in many cases reduced size. Products included are integrated circuits, multi-layer printed circuit boards and surface-mounted components such as capacitors and resistors.
Flexible Manufacturing	Encompasses advances in robotics, numerically-controlled machine tools, and similar products involving industrial automation that allow for greater flexibility to the manufacturing process and reduce the amount of human intervention. Includes robots, numerically controlled machine tools and semiconductor production and assembly machines.
Advanced Materials	Encompasses recent advances in the development of materials that allow for further development and application of other advanced technologies. Examples are semiconductor materials, optical fiber cable and video discs.

Aerospace	Encompasses most new military and civil helicopters, airplanes and spacecraft (with the exception of communications satellites that are included under Information & Communications Technology). Other products included are turbojet aircraft engines, flight simulators and automatic pilots.
Weapons	Primarily encompasses products with military application. Includes such products as guided missiles and parts, bombs, torpedoes, mines, missiles, rocket launchers and some firearms.
Nuclear Technology	Encompasses nuclear power production apparatus. Includes nuclear reactors and parts, isotopic separation equipment and fuel cartridges. Excludes nuclear medical apparatus, which is included under Life Science Technology.