DISCUSSION PAPER No.94

Modes of International Activities and the Innovativeness of Firms: An Empirical Analysis Based on the Japanese National Innovation Surveys for 2003 and 2009

2013 年 6 月

文部科学省　科学技術政策研究所

第 1 研究グループ

羽田尚子　伊藤恵子　米谷悠

本 DISCUSSION PAPER は、所内での討論に用いるとともに、関係の方々からのご意見をいただくことを目的に作成したものである。

また、本 DISCUSSION PAPER の内容は、執筆者の見解に基づいてまとめられたものであり、機関の公式の見解を示すものではないことに留意されたい。

DISCUSSION PAPER No.94

Modes of International Activities and the Innovativeness of Firms: An Empirical Analysis Based on the Japanese National Innovation Surveys for 2003 and 2009

Shoko HANEDA, Keiko ITO and Yutaka YONETANI

June 2013

First Theory-Oriented Research Group
National Institute of Science and Technology Policy (NISTEP)
Ministry of Education, Culture, Sports, Science and Technology (MEXT)
Japan

Modes of International Activities and the Innovativeness of Firms: An Empirical Analysis Based on the Japanese National Innovation Surveys for 2003 and 2009

文部科学省 科学技術政策研究所 第 1 研究グループ 羽田尚子 伊藤恵子 米谷悠

要旨

本稿では、文部科学省が 2003 年と 2009 年に実施した「全国イノベーション調査」の個票データを利用して、国際展開を行っている企業と国際展開を行ってていない企業において、イノベーション活動にどのような差異があるかを実証分析している。具体的には、Mairesse and Mohnen (2001、2002)、Mohnen et al. (2006) が提唱する「イノベーション会計」という手法を適用し、生産、販売、研究開発といった事業活動を国内のみで行っているか、または海外でも行っているかによって、イノベーションの効率性が異なるかを定量的に分析する。

分析結果から、まず、国際展開を行っている企業は、より多くのインプットを用いてより多くのイノベーション成果を生み出していることが確認された。イノベーション成果は、海外に研究開発拠点を持つ企業で最も大きく、次いで海外に販売・生産拠点のある企業、販売拠点のみの企業、生産拠点のみの企業の順となっていた。イノベーションの成功確率の大部分は、企業内スピルオーバー効果や研究開発集約度、競争に対する姿勢、基礎研究へのアクセスといった構造的要因で説明できる。しかし、新プロダクトの売上高についてはこれらの構造的要因では説明できない部分も大きく、国際展開を行っている企業では高いイノベーション効率性を実現し、それが大きな売上高をもたらすことも確認された。幅広く国際展開を行っている企業は、海外のさまざまな企業や大学・研究機関とイノベーション活動での協力を行っている企業が多く、多様な海外の情報源を活用することによって、高いイノベーション効率性を実現していると推測される。

Modes of International Activities and the Innovativeness of Firms: An Empirical Analysis Based on the Japanese National Innovation Surveys for 2003 and 2009

Shoko HANEDA, Keiko ITO and Yutaka YONETANI, First Theory-Oriented Research Group, National Institute of Science and Technology Policy (NISTEP), MEXT

ABSTRACT

In this paper, we investigate differences in innovation activities between firms with international activities and firms without such activities, utilizing the firm-level data underlying the Japanese National Innovation Surveys for 2003 and 2009. We quantitatively examine the factors which account for differences in innovation output depending on the mode of international activities, employing the innovation accounting framework proposed by Mairesse and Mohnen (2001, 2002) and Mohnen, Mairesse, and Dagenais (2006).

We find that internationally engaged firms use more innovation inputs and generate more innovation output. In particular, firms with R&D establishments abroad show the best innovation performance, followed, in that order, by firms with both sales and production establishments abroad, firms with overseas sales only, and firms with production establishments abroad only. We further find that a significant part of the higher innovation performance of firms with international activities can be explained by their greater intra-group or intra-firm knowledge spillovers, R&D intensity, perceived competitive pressure, and proximity to basic research. However, more importantly, firms with

international activities are much more efficient in innovation when measuring innovation output in terms of the sales turnover of innovative products. Although engagement in international activities itself does not raise the probability that a firm successfully develops a new product or process, it greatly increases the sales amount of innovative products.

概要

概要

1. 研究の背景と目的

貿易や直接投資を通じて国際的に事業を展開している企業は、そうでない企業よりも生産性などのパフォーマンスが優れていることが数多くの先行研究において示されている。また、こうした国際化企業は、研究開発も活発に行っている傾向がある。つまり、企業のパフォーマンスとイノベーション、そして国際事業展開との間には、正の相関関係が見られることが多く、これらの間には何らかの相互作用が働いているのではないかと考えられている。

欧州諸国を中心にいくつかの先行研究において、この相互作用のメカニズムの解明が試みられてきた。例えば、イノベーションが国際化を促進するのか、または国際化がイノベーションを促進するのか、といった因果関係の解明も先行研究では行われている。また、Criscuolo et al. (2010)は、国際化した企業は研究開発活動に対するインプット(研究開発人員の数や利用可能な情報量)が多いことにより、イノベーションの成果も大きいことを示している。国際化した企業がより効率的なイノベーション活動を行っていることが示唆されるものの、これら企業のイノベーションの優位性の大部分はインプットの大きさによって説明されると結論づけている。

一方、日本についても、輸出を開始した企業が研究開発投資を増やし、さらには生産性も向上させる傾向があることや(Ito 2011)、海外市場での顧客や競争相手とのやりとりといった海外での経験が、その後のイノベーション活動にプラスに作用することなどが先行研究で示されている(Yashiro and Hirano 2010)。ただし、イノベーションに関連する研究では多くの場合、イノベーションの成果を測定することが難しい。イノベーションの成果を表す変数として、通常、特許取得件数やイノベーション(新しいプロダクトまたはプロセスの開発)の有無、新しいプロダクトの売上高などが用いられるが、日本においては、事業の国際化とイノベーション成果との関連を、これらの指標を用いて分析した研究がほとんどない。Yashiro and Hirano (2010) が、プロダクトまたはプロセスイノベーションの有無や特許取得の有無といった指標を用いて、日本企業の輸出開始とイノベーション成果との関係を分析した唯一の研究ともいえるが、彼らの研究は中小企業を対象としており、輸出開始に焦点を当て、多国籍企業については分析されていない。

これらの国内外の先行研究から、国際化している企業はイノベーション活動へのインプットが多く、その結果としてイノベーションの成功確率も高いことが示唆される。しかし、国際化企業ではイノベーションの効率性が高いのか否か、また、イノベーションの有無だけではなくイノベーション成果の重要度(例えば新プロダクトの売上高の大きさ)の面で国際事業展開に起因する優位性があるのかどうかなど、まだ十分に解明されていない疑問は多い。

そこで、本研究では、文部科学省科学技術政策研究所「全国イノベーション調査」の個票データを利用して、国際展開をしている企業とそうでない企業とにおいて、イノベーション活動にどのような差異がみられるのか、または両者の間でイノベーションの効率性に違いがあるのかを実証分析している。本研究では、Mairesse and Mohnen (2001、 2002)、Mohnen et al. (2006) が提唱する「イノベーション会計」という分析手法を適用して、先行研究では十分に解明されていない、事業活動範囲に起因する差異を計測している点に特徴がある。つまり、生産、販売、研究開発といった事業活動を国内のみで行っているか、または海外でも行っているかによって、イノベーションの効率性にどの程度の差異があるのかを定量的に分析するものである。

また、「全国イノベーション調査」のデータを利用することにより、プロダクトまたはプロセスイノベー

ションの有無や新プロダクトの売上高といったイノベーション成果に関連する情報を使用して分析している。イノベーション活動のための戦略やパートナー、情報源などについても分析に利用している。これらの情報は、通常の企業財務データでは得られないものであり、日本企業について、国際事業展開の有無とイノベーション活動の特徴との間に何らかの関連性があるかどうかを詳細に分析した最初の実証研究といえる。

2. 利用したデータ

すでに述べたように、本研究では、「全国イノベーション調査」の個票データを利用している。同調査は、イノベーション活動を測定・分析する際の標準的なガイドラインであるオスロ・マニュアルに準拠して実施されたものであり、たとえば、欧州諸国で定期的に実施されている Community Innovation Survey (CIS) の日本版調査ともいえる。近年、欧州諸国では、CIS の個票データを利用して、イノベーションと企業パフォーマンス等との関係を解明する研究が盛んに行われているが、日本では同調査を活用した学術研究はまだ非常に少数にとどまっている。

本研究では、同調査の第1回調査（以下 2003 年調査と記す）および第2回調査（以下 2009 年調査と記す）のデータを利用したが、2003 年調査と 2009 年調査では、調査対象となった企業の規模分布が大きく異なっている。2003 年調査では、製造業に属する回答企業のうち、48％が小企業（従業員数 10－49 人）、36％が中企業（従業員数 50－249 人）、16％が大企業（従業員数 250 人以上）と、小企業が約半数を占めていたのに対し、2009 年調査では、大企業が過半の 51％、小企業が 22％となっている。また、両調査ともにオスロ・マニュアルに準拠しているものの、質問の問い方や回答の選択肢などに多くの違いがみられる。そこで、本研究では、2 つの調査データのパネル化を断念し、各調査を別々に扱い、個々に横断面で分析する。なお、本研究では、企業活動の国際化とイノベーションに焦点を当てていることから、分析対象を製造業企業に限定した。非製造業に属する回答企業のうち多くは、研究開発費や海外活動拠点などに関する設問に回答していないためである。また、データの信頼性を確保するため、研究開発集約度（研究開発費対売上高比率）が 80 パーセントを超えている企業と、基礎的な情報である売上高を回答していない企業は、分析対象から除外した。その結果、本研究の分析対象は、2003 年調査で 6093 社、2009 年調査で 1587 社の製造業企業となった。

3. 分析方法

本研究の分析は、主に 3 つの部分から成り立っている。まず、分析対象企業を国際事業展開の有無とその範囲に基づいて 5 つのグループに分類し、各グループのイノベーション活動の特徴を概観する。次に、知識生産関数を推定することにより、イノベーション実現の決定要因を推定する。最後に、Mairesse and Mohnen (2001、 2002)、Mohnen et al. (2006) が提唱する「イノベーション会計」という分析手法を適用して、国際事業展開の範囲によってイノベーションの効率性がどの程度異なるのかを測定している。

「イノベーション会計」という分析手法について説明する前に、まず、知識生産関数の推定について述べる。知識生産関数とは、イノベーション活動のインプットとアウトプットとの関係を表すものであるが、本研究では、プロダクトまたはプロセスイノベーションの有無（イノベーションがあった場合に 1、

なかった場合は 0)、または、新プロダクトの売上高をイノベーション活動のアウトプットの代理変数として用いる。イノベーション活動のインプットとしては研究開発集約度を用いる。さらに、イノベーションの実現にむけた知識の蓄積に影響を与えると考えられる要因として、Mairesse and Mohnen (2001、 2002)、Mohnen et al. (2006)にならい、企業規模、企業グループへの所属の有無、競争に対する姿勢、イノベーションにおける高等教育・研究機関からの情報入手の有無、産業ダミーを用いた。企業規模は、金融市場へのアクセスの容易さや規模の経済といったスケールメリットを表す変数である。企業グループへの所属は、技術のスピルオーバーや組織のシナジー効果を表す。グループ内の知識を効率的に活用することでイノベーションの実現能力がより高くなり、成果を享受しやすいと推測した。ただし、2009 年調査ではグループへの所属についての質問がないため、スピルオーバーの代理変数として、企業内の部門間連携を促進するような施策を行ったか否かの情報を用いた。競争に対する姿勢は、プロダクトイノベーションのインセンティブの強さを表すものである。2003 年調査については、他者とは異なるオリジナルのプロダクトを提供するために戦略的行動をとったか否かの質問に対する回答から変数を作成した。こうした戦略的行動をとる企業は、競争を意識していると推測できるためである。2009 年調査では戦略的行動に関する質問をしていないため、市場構造の変化に関する質問をもとに競争に対する姿勢を測定した。具体的には、市場において製品・サービスの多様化が進んだか否かの質問に対する回答から変数を作成した。高等教育・研究機関からの情報入手の有無は、技術シーズである基礎研究へのアクセスを表している。また、産業による技術的機会の差異、政策支援の差異、需要の違いなどを考慮した推定を行うために産業ダミーも分析に含めた。本研究では、分析対象企業を国際事業展開の有無とその範囲に基づいて 5 つのグループに分類して分析しているが、5 つのグループに対応するダミー変数も企業の海外事業展開を表す変数として分析に含めた。5 つのグループは、以下のように分類している。第1グループは、日本以外の地域に製品の生産拠点をもっているが、海外での販売・提供や研究開発拠点はない企業である(以下「海外生産拠点のみ」と記す)。第2グループは、海外に生産拠点があり、かつ製品・サービスの販売・提供も海外で行っている企業である(以下「海外生産・販売拠点あり」と記す)。第3グループは、海外で製品・サービスを販売・提供しているが、生産拠点は海外にない企業である(以下「海外販売拠点のみ」と記す)。第4グループは、海外に研究開発拠点をもつ企業である(以下「海外研究開発拠点あり」と記す)。なお、これらの企業は、海外に生産または販売拠点、またはその両方を持っているケースも多い。第5グループは、上記1～4いずれにも該当しない企業、すなわち海外での事業展開を全く行っていない企業である(以下「海外展開なし」と記す)。本文の Table 1 に、各グループに該当する企業数を産業毎にまとめている。

これらの変数を利用して、知識生産関数を推定した結果は、本文の Table 5～Table 8 に示すとおりであるが、推計結果については、次節で詳述する。推定された知識生産関数に基づいて、イノベーションの効率性を計測するのが、「イノベーション会計」である。イノベーション会計とは、生産性の計測に適用する成長会計と類似した考え方である。イノベーションの成果は、知識創造活動に対するインプットの量や産業・企業特殊的な要因や外部環境要因など、さまざまな構造要因によってもたらされる部分と、それらの構造的要因で説明できない、何らかの効率性要因によってもたらされる部分とによって構成されていると考えるものである。上に述べた知識生産関数において、説明変数として含めた要因によって説明される部分が構造的要因に対応する。そして、イノベーション成果のうち、知識生産関数の説明変数で説明できない部分が、イノベーションの効率性と定義され、Mairesse 等は「プロダクティビティ(生産性)」に対応させて、「イノバティビティ」と呼んでいる。イノバ

ティビティとはすなわち、知識生産関数に対する残差で計測され、生産関数に対する全要素生産性（TFP）に対応するものを指している（Mairesse and Mohnen 2002）。

本研究では、国際事業展開の形態別に、イノベーション成果をもたらす要因がどの程度異なるのかを、イノベーション会計の方法を適用して数量的に計測する。さまざまな構造要因で説明できる部分と、国際展開によって得られる効率性の部分との相対的な大きさを計測できるところに特徴がある。

4. 分析結果

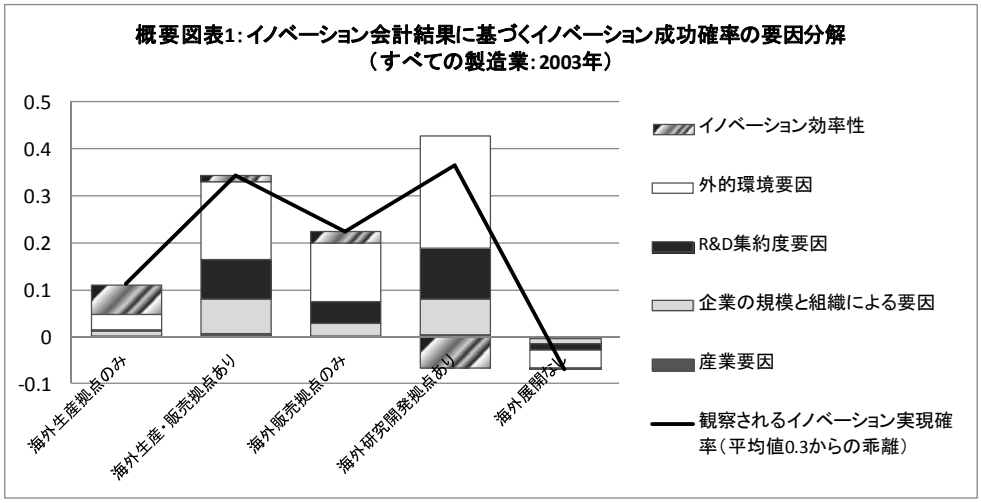
まず、本研究の第一の分析は、国際事業展開の形態ごとに、イノベーション活動の特徴を概観するものである。本文の Table 2～Table 4 にあるように、「全国イノベーション調査」に対する各企業の回答を集計すると、国際事業展開の形態ごとに、イノベーション活動のインプットや成果、情報源、公的支援や成果の保護方法など、さまざまな差異がみられた。これらの表から主に観察されることは、以下のとおりである。まず、国際化をしている企業の方がイノベーションを実現している割合が高い。なかでも海外に研究開発拠点のある企業は、イノベーションのインプットである研究開発活動に積極的であり、公的助成を受け入れている企業比率も高い。これらの企業はイノベーション活動における自社外の組織との協力にも積極的であり、海外のパートナーと共同でイノベーション活動を行ったことのある企業の割合が高いことも注目される。また、プロダクトイノベーションによる、「製品・サービスの範囲を拡大させる効果」や「製品・サービスの質を高める効果」についても、国際化している企業の方が、目標以上の達成を実現したと回答している企業の割合が大きい。

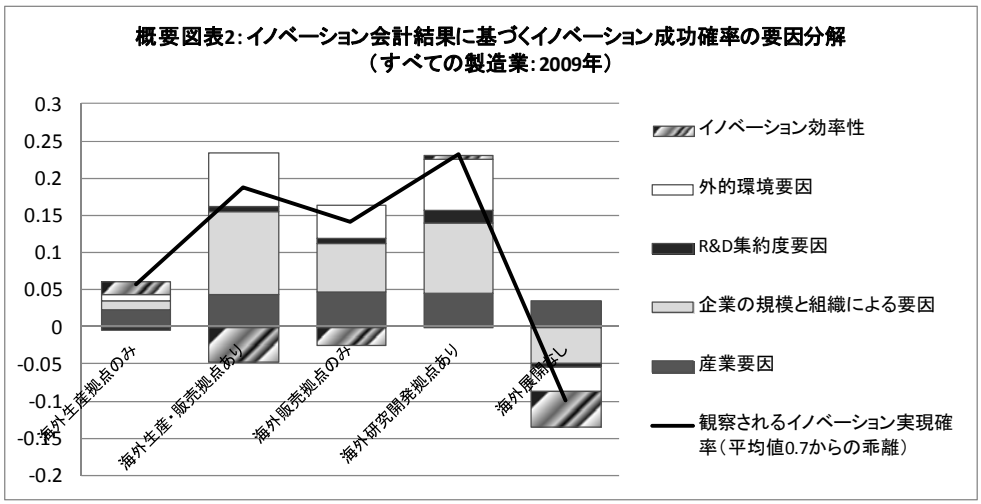
次に、上述の知識生産関数の推定結果について説明する。すでに述べたとおり、本研究では 2 種類の知識生産関数を推定する。つまり、プロダクトまたはプロセスイノベーションを実現したか否かをイノベーションのアウトプットと捉える関数と、自社にとって新しいプロダクトの売上高の大きさをイノベーションのアウトプットと捉える関数との 2 つである。前者については、イノベーションの成功確率を説明する関数を推定することになり、プロビット・モデルで推定した結果は本文の Table 5 と Table 6 のとおりである。後者については、新プロダクトの売上の大きさを説明する関数をトービット・モデルで推定し、その結果は本文の Table 7 と Table 8 のとおりである。

本文の Table 5～Table 8 より、2003 年、2009 年ともに、構造的要因を示す説明変数のほとんどが正で有意な限界効果を持っており、これらの構造的要因によって、イノベーションの成果が説明できることが分かる。つまり、企業規模の大きい企業はイノベーション成果が大きく、また、企業内または企業グループ内での知識スピルオーバーや研究開発集約度の大きさもイノベーション成果に正の効果をもたらす。市場競争環境や教育・研究機関との近接といった外部環境要因も限界効果が大きく、イノベーション成果に対する重要な決定要因であることが分かる。国際事業展開の形態については、いくつか統計的に有意でない結果もあるものの、ほとんどすべてのケースで正の限界効果が確認され、国際化している企業ほど、イノベーション成果が大きいことが確認された。なお、生産と販売の両方、または研究開発拠点まで海外に所有するような、より幅広い活動を海外で展開している企業のほうが、イノベーション成果が大きい傾向があることも確認できる。

これらの知識生産関数の推定結果を「イノベーション会計」に適用した結果が本文の Table 9～Table 12 である。これらの表から主な結果を抜粋し、イノベーション成果の要因分解結果を図示してみよう。まず、本文の Table 9 に基づき、2003 年のイノベーション成功確率について、国際事業展開

の形態別に要因分解した結果を概要図表 1 に示す。2003 年において、プロダクトまたはプロセスイノベーションを実現したと答えた企業の割合は全体の 30 パーセントであり、平均的なイノベーション成功確率は 0.3 と考えられる。国際事業展開形態別に分類した企業の平均的な成功確率が、この全体平均の成功確率からどれだけ乖離しているかを示したのが、概要図表 1 の折れ線グラフである。さらに、この乖離分を構造的要因とイノベーション効率性に要因分解した結果が、概要図表 1 の棒グラフで示されている。本文の Table 10 に基づき、2009 年の要因分解結果を同様に図示したのが概要図表 2 である。

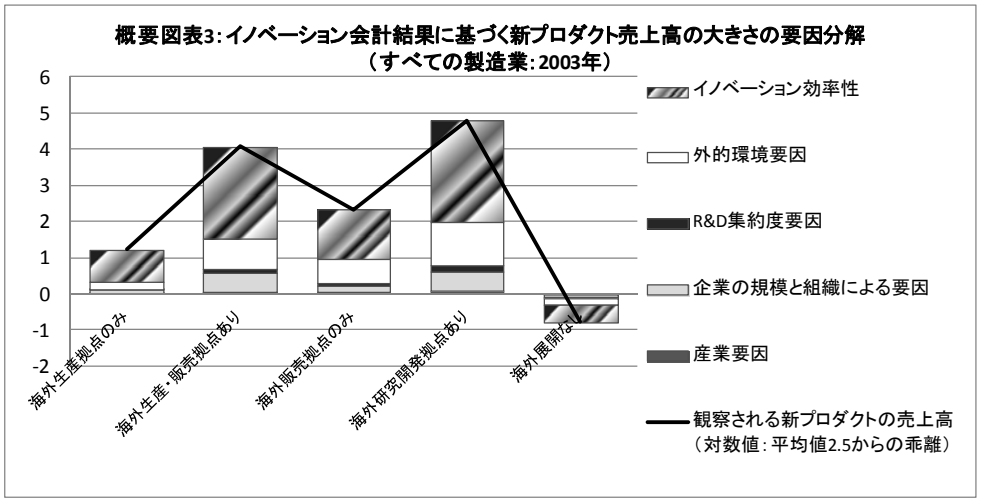


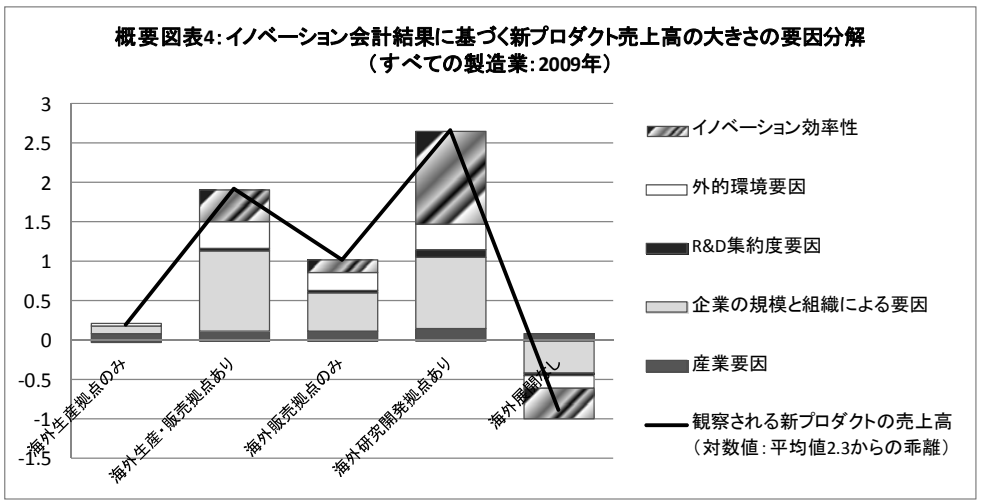


概要図表 1、2 より、イノベーション成功確率の大きさは、企業規模と組織による要因と外的環境要因によって説明される部分が大きいことが分かる。2003 年では、研究開発集約度の要因が比較的大きく、2009 年では産業要因が比較的大きいという違いはあるが、両年ともに「イノベーション効率性」（Mairesse らが「イノバティビティ」と呼ぶ要因）によって説明される部分はあまり大きくない。これらの結果から、海外に幅広く事業展開している企業のほうがイノベーション成功確率は高いものの、これら企業は市場競争を意識した戦略をとっていることや規模が大きくスケールメリットなどを活かせることなどによって、より高いイノベーション成功確率を実現している部分が大きいといえる。

しかし、このイノベーション成功確率の指標は、イノベーション成果の大きさや重要性を捉えてい

ない。そこで、新プロダクトの売上高をイノベーション成果の指標として用いた結果（本文の Table 11 と Table 12）に基づき、概要図表 1、2 と同様に要因分解結果を図示しよう。まず、2003 年の新プロダクト売上高について、国際事業展開の形態別に要因分解した結果を概要図表 3 に示す。2003 年において、全企業平均の新プロダクト売上高は約 2.5（対数値）であった。国際事業展開形態別に分類した企業の平均的な新プロダクト売上高が、この全体平均の売上高からどれだけ乖離しているかを示したのが、概要図表 3 の折れ線グラフである。さらに、この乖離分を構造的要因とイノベーション効率性に要因分解した結果が、概要図表 3 の棒グラフで示されている。同様に、2009 年の要因分解結果を同様に図示したのが概要図表 4 である。





概要図表 3、4 ともに、概要図表 1、2 のイノベーション成功確率の要因分解と同様、企業規模と組織による要因と外的環境要因によって説明される部分が大きいことが分かる。しかし、イノベーション成功確率の場合と異なり、新プロダクトの売上高に関しては、「イノベーション効率性」によって説明される部分が大きい。特に、海外に研究開発拠点を持ち、より幅広く国際事業展開をしている企業において、イノベーション効率性が高く、新プロダクトの売上高が大きいことが分かる。つまり、国際事業展開していること自体が、イノベーションを実現したか否かの確率には大きな影響を与えないが、より大きなイノベーション成果を得られるか否かについては国際事業展開によって何らかの

正の効果を得ていることが示唆される。また、この正の効果の量的なインパクトは非常に大きいといえる。

たとえば、2003 年において全企業の新プロダクト売上高の平均値は対数値で約 2.5 であるが、海外に研究開発拠点を持つ企業の新プロダクト売上高の平均値は対数値で約 7.3 である。つまり、概算で、これら企業の新プロダクト売上高は全体平均の 120 倍にもなる。構造的要因によって説明できる売上高（対数値で 4.5）をみると、全体平均の売上高の約 7 倍となるので、2003 年については、国際事業展開に起因するイノベーション効率性によって売上が格段に大きくなっているといえる。ただし、2003 年調査では小規模企業が多く、プロダクトイノベーションを実現していないため、新プロダクトの売上高がゼロとなっている企業が大多数である。そのため、全体平均の新プロダクト売上高と海外に研究開発拠点を持つ企業の新プロダクト売上高の平均値との乖離が非常に大きくなっている。2009 年においても同様な結果であるが、2009 年では、海外に研究開発拠点を持つ企業の新プロダクト売上高の平均値は全体平均の約 14 倍である。構造的要因で説明できる売上高は、全体平均の約 4.5 倍であるため、14 倍と 4.5 倍との差の部分が、イノベーション効率性によってもたらされた売上ということになる。これらの結果から、国際的に幅広く事業展開することは、イノベーション成果の大きさに関して、大きな正の効果を持つことが示唆される。

では、国際事業展開に起因するイノベーション効率性とは、具体的にどのような要因なのであろうか。すでに述べたように、国際化企業では、自社以外の他社とイノベーション活動において協力している企業の割合が高く、特に、海外の企業や組織と協力している企業の割合が高い（本文の Table 2）。また国際化している企業はそうでない企業と比べ、海外の顧客、高等教育・研究機関といった多様な機関とイノベーションのための協力関係にあることも読み取ることができる。このことから、国際化企業は、海外の多様な情報源やパートナーを活用することにより、より広い市場で大きな売上高を実現できるようなイノベーションを行っていると推測できる。

さらに詳細にイノベーション・パートナーのタイプを見てみると（本文の Table 13）、海外に研究開発拠点を持つ企業は、海外の他の組織と共同でイノベーション活動を実施する企業が多い上に、さまざまなタイプの海外パートナーと共同でイノベーション活動を行っていることが確認できる。たとえば海外の顧客や教育・研究機関のみならず、海外の競合他社や研究開発を事業として行う民間のラボや企業なども、イノベーションのパートナーとしている企業が相当数ある。また、販売拠点を海外にもつ企業では、海外の顧客と共同でイノベーション活動を行ったと回答している企業の割合が高い。これらの海外パートナーからの情報を活用し、現地の市場に適合した新プロダクトの開発・改良を行っていることが、新プロダクトの高い売上高につながっているのではないかと考えられる。

5. 結論と政策的含意

本研究の分析結果から、まず、国際化をしている企業は、構造的にもイノベーションを実現しやすい属性を持ち、より多くのインプットを用いてより多くのイノベーション成果を生み出していることが確認された。「全国イノベーション調査」の集計結果から、国際化している企業は、平均的な企業と比べて、研究開発集約度が高く、スケールメリットやスピルオーバーを享受している傾向がみられる（イノベーション活動へのインプットが大きい）。また、研究開発が活発な産業に属する企業が多く、競争を意識し、基礎研究にアクセスしている企業が多かった。そして、「イノベーション会計」の分析から、これらの構造的要因によって、国際化をしている企業はイノベーションの成功確率が高いことが

示された。ただし、イノベーションを実現したか否かだけではなく、イノベーション成果の大きさ（新プロダクトの売上高）の決定要因をみると、これらの構造要因だけでは説明できない部分も大きく、国際的に事業を展開していることによって高いイノベーション効率性を実現し、それがイノベーション成果の大きさに結び付いていることも確認された。イノベーション効率性は、海外に研究開発拠点を持つ企業で最も高く、次いで海外に販売・生産拠点のある企業、販売拠点のみ、生産拠点のみの順となっていた。研究開発なども含めて幅広く国際事業展開を行っている企業は、海外の顧客や大学・公的研究機関のみならず、海外の競合企業や海外の民間研究ラボなどともイノベーションの協力を行っている企業が多く、多様かつ多くの海外の情報源を活用することによって、高いイノベーション効率性を実現していると推察される。

これらの結果から、イノベーションを実現するか否かに関しては、国際的に事業展開していなくとも、イノベーションのインプットを増やすことによって、ある程度成功確率を高めることができると予測できる。しかし、実現したイノベーションからより大きな成果（より大きな売上を得て、さらにより大きな利益につなげる）を得るためには、国際的な事業展開を通じてイノベーションの効率性を上げることが重要であることが示唆される。

最後に残された課題と今後の展望について簡潔に述べる。本研究の結果から、より大きなイノベーション成果を得るという点では、国際的に事業を展開していることに起因するメリットが大きいことが分かった。しかし、国際展開していることがどのようなメカニズムでメリット（イノベーション効率性）に結びつくのか、そのメカニズムまでを厳密に分析するには至っていない。海外情報源の活用も説明の一つであろうが、国内市場と海外市場における競争の度合いや競争の質の違いによるイノベーションへのインセンティブの差などもあるかもしれない。また、海外でどのようなタイプの研究開発を行っているかによって、売上の大きさへの影響も異なるかもしれない。たとえば、基礎的な研究なのか、または、現地市場向けの仕様変更・改良なのかによっても、イノベーション効率性に違いがあるかもしれない。新プロダクトの技術的難易度やプロダクトのタイプについて十分に考慮できていない、といった問題も挙げられる。また、本研究の分析枠組では、イノベーションと国際展開との因果関係については議論することができない。企業は、それぞれ異なるインセンティブのもとに意思決定を行っていることを考慮すると、イノベーションと国際展開の動機、そして両者の因果関係をより深く理解・分析していくことが、両者の相互作用の解明につながるだろう。

これらの課題については、本研究で用いた「全国イノベーション調査」のデータだけでは分析できない部分も多い。たとえば欧州諸国では、CIS 調査結果の蓄積が進み、企業レベルのパネル・データ化や他のデータベースと接合したデータの分析なども進展している。日本においても、第 3 回調査を 2013 年に実施したため、調査データの蓄積とその積極的な分析・活用を通じて、日本企業がより効率的にイノベーションを実現し、より大きな成果を得ることを可能にするための政策立案・環境整備につなげていくことが重要である。

参考文献

Criscuolo, Chiara, Jonathan E. Haskel, and Matthew J. Slaughter (2010) “Global Engagement and the Innovation Activities of Firms,” *International Journal of Industrial Organization* 28, pp.191-202.

Ito, Keiko (2011) “Sources of Learning-by-Exporting Effects: Does Exporting Promote Innovation?” *FREIT Working Paper Series* No. 295, Forum for Research in Empirical International Trade.

Mairesse, Jacques and Pierre Mohnen (2001) “To Be or Not To Be Innovative: An Exercise in Measurement,” *NBER Working Paper* 8644, December, National Bureau of Economic Research.

Mairesse, Jacques and Pierre Mohnen (2002) “Accounting for Innovation and Measuring Innovativeness: An Illustrative Framework and an Application,” *American Economic Review*, 92 (2): 226-230.

Mohnen, Pierre, Jacques Mairesse, and Marcel Dagenais (2006) “Innovativity: A Comparison Across Seven European Countries,” *Economics of Innovation and New Technology*, 15 (4-5): 391-413.

Yashiro, Naomitsu and Daisuke Hirano (2010) “Anatomy of Learning-from-Exporting: Role of Foreign Knowledge Acquisition,” *RIETI Discussion Paper Series* 10-E-053, October, Research Institute of Economy, Trade and Industry.

本文

1. Introduction

A large number of empirical studies suggest that firms engaged in international trade and investment perform better than firms not engaged in such activities, and the reasons why the former outperform the latter have been intensively investigated in empirical studies in many countries. One possible explanation, which has received considerable empirical support, is the selection effect reflecting the fact that only high-performing firms can afford the fixed costs required to start exporting or to conduct foreign direct investment (FDI). Another possible explanation is that exposure to international markets leads to an improvement in productivity through "learning effects" based on access to technical expertise from overseas markets. The empirical evidence regarding this hypothesis, however, has been less clear-cut.[1] Although some recent empirical studies do find evidence of a positive learning-by-exporting effect (e.g., Girma, Greenaway, and Kneller, 2004; De Loecker, 2007), both theoretical and empirical studies to date have not adequately explored the mechanisms underlying the learning-from-international-markets effect and the conditions under which firms can learn from overseas markets (foreign customers, competitors, and partners) and enhance their performance.

A possible explanation for the high performance of firms engaged in international activities and the positive learning effect from international activities is the existence of some kind of interaction between international activities and domestic innovation activities, given that firms with international activities tend to be more R&D-intensive than firms without international activities.[2] In fact, in recent years, an increasing number of empirical studies have tried to identify the missing link between innovation, performance, and exporting/FDI based on the recognition of the importance of firms' innovative activities for their technological progress and productivity growth, as suggested by theories of firms' growth and endogenous growth theory (Romer, 1990, etc.). For example, there are several studies which find complementarities between exporting and innovation (Aw, Roberts, and Winston, 2007; Aw, Roberts, and Xu, 2011; Damijan, Kostevc, and Polanec, 2010; Roper and Love, 2002; Castellani and Zanfei, 2007). Moreover, for the United Kingdom, Criscuolo, Haskel, and Slaughter (2010) show that globally engaged firms generate more innovation output and use more inputs for knowledge production and that their innovation-output advantage is accounted for by their greater use of knowledge inputs. They suggest that globally engaged firms devote more resources to assimilate knowledge from abroad and generate more innovations, suggesting that there is positive interaction between innovation and international activities. Similarly, Love and Ganotakis (2013) find that exporting helps U.K. high-tech small and medium-sized enterprises to innovate subsequently. Further, although Girma, Görg, and Hanley (2008) find that exporting does not have a significant effect on R&D for British

[1] See Wagner (2007, 2012) for a survey.

[2] There are a number of studies that find that firms engaged in international activities show a higher R&D intensity than firms without such activities. Examples include the studies by Criscuolo et al. (2010) for the case of the United Kingdom and Wagner (2006) for the case of Germany. Studies confirming the pattern for Japan include Kimura and Kiyota (2006) and Fukao and Kwon (2006).

firms, they do find a positive causal effect of previous exporting experience on the innovative capability for Irish firms. Finally, focusing on Spanish firms, Salomon and Shaver (2005) find evidence for learning by exporting in terms of both increased product innovation and patent counts. Blind and Jungmittag (2004) also find a positive effect of exporting on innovation for firms in the German service sector.

Although these studies support the idea that there is positive interaction between international activities and innovation, our knowledge on this interaction is still rather limited. A considerable number of questions remain, such as with regard to whether and how firms' experience in foreign markets affects domestic innovation activities; what kind of international business activities have the greatest effect on domestic innovation activities; and which sources of information and/or what types of information help firms upgrade their technology or products.

This is especially the case for Japan, where empirical evidence on the link between international activities and innovation is scant. Exceptions include the study by Ito (2011), which finds that firms that started exporting become more R&D intensive and increase R&D inputs (R&D expenditures and R&D employees), and that by Yashiro and Hirano (2010), which shows that exporters engaged in information gathering from foreign markets are more successful in innovation. Although the study by Yashiro and Hirano (2010) provides new insights by explicitly capturing the role of knowledge acquisition from foreign markets, due to data constraints it fails to provide any details on exporters' information gathering activities.

Against this background, the aim of this study, utilizing the firm-level data underlying the Japanese National Innovation Surveys, is twofold. First, it seeks to examine in detail the characteristics of the international activities and innovation activities of Japanese manufacturing firms. Second, based on this more qualitative analysis, it then seeks to examine quantitatively the factors which account for differences in innovation output depending on firms' internationalization status in order to better understand the mechanisms underlying learning from international markets. Our study is closely related to that by Criscuolo, Haskel, and Slaughter (2010), which attempts to explain differences in innovation performance between globally engaged and domestic firms by focusing on differences in various innovation inputs and in the information available to a firm. However, our study goes a step further by investigating the differences by distinguishing the mode and the extent of global engagement, i.e., whether firms only export, whether they both export and engage in overseas production, or whether they also conduct overseas R&D, etc. As in Criscuolo, Haskel, and Slaughter (2010), we employ a knowledge production function framework to identify the relationship between innovation output and knowledge inputs.[3] Using this framework, we try to reveal how firms engaged in international activities differ from those not engaged in such activities in terms of innovation inputs and output.

[3] The knowledge production function framework has been widely employed in the literature on productivity growth and innovation activities at both the macro- and the micro-level (see, for example, Griliches, 1998, and Jaffe and Trajtenberg, 2002). Many studies have employed the so-called CDM model, which formulates the relationship between innovation input and output and the contribution of the knowledge stock to productivity growth (Crépon, Duguet, and Mairesse 1998).

We also quantitatively measure the differences in innovation efficiency across firms with different modes of international activities, using the innovation accounting framework proposed by Mairesse and Mohnen (2001, 2002) and Mohnen, Mairesse, and Dagenais (2006).

The results of this study can be summarized as follows. First, we show that internationally engaged firms use more innovation inputs and generate more innovation outputs, which is consistent with the results obtained by Criscuolo, Haskel, and Slaughter (2010). Second, we find that internationally engaged firms differ significantly from domestic firms in terms of their market strategies, information sources, innovation partners, and so on, which also affects innovation outputs. And third, based on the innovation accounting framework, we find that international activities greatly increase firms' innovation efficiency and thereby increase firms' sales turnover of innovative products (hereafter referred to as "innovative sales" for brevity). In other words, engagement in international activities does matter for innovation efficiency when measuring innovation output in terms of innovative sales. On the other hand, when considering innovation output in terms of whether a firm developed new or changed products or processes regardless of the amount of sales generated by that innovation, engagement in international activities itself is not relevant for improvement in innovation efficiency. Moreover, firms with a wider extent of international engagement show greater innovativeness, suggesting that the better innovation performance of such firms may be based on the utilization of various foreign innovation sources and partners.

The data we use for our analysis are the micro-data underlying the Japanese National Innovation Surveys conducted by the Ministry of Education, Culture, Sports, Science and Technology in 2003 and 2009. These surveys are the Japanese version of the Community Innovation Surveys (CIS) conducted by the European Union. While the CIS surveys have been widely used for analyses on European firms' innovation activities, including the studies mentioned above, the Japanese National Innovation Surveys, with the exception of the studies by Kwon, Fukao, and Kim (2008) and Isogawa, Nishikawa, and Ohashi (2012), have not been used for any rigorous academic analyses. This paper is the first study to use Japanese National Innovation Survey data to provide quantitative evidence on the interaction between innovation and firms' international activities.

The organization of this paper is as follows. Section 2 describes the dataset used in this paper and discusses various characteristics of the innovation activities of Japanese firms. Section 3 then explains the framework of the econometric analysis and presents the results. Finally, Section 4 concludes.

2. Innovation and the International Activities of Japanese Firms

2.1 Data

The data used in this study are the firm-level data from the Japanese National Innovation Surveys (JNIS). The surveys are based on the Oslo Manual and provide a wide range of information on firms' innovation activities and their outcome such as the sale of products which embody

innovations new to the firm or the market.

In the 2003 survey, the questionnaire was sent out to 43,174 firms with 10 or more employees, and 9,257 firms answered the questionnaire (for a response rate of 21%).[4] As for the 2009 survey, the questionnaire was sent out to 15,137 firms with 10 or more employees, and 4,579 firms answered the questionnaire (for a response rate of 30%).[5] Of the firms that answered, 68% for the 2003 survey and 41% for the 2009 survey hailed from the manufacturing sector. Among these manufacturing firms, in the 2003 survey, 48% were small firms (with 10-49 employees), 36% were medium-sized firms (50-249 employees), and 16% were large firms (250 or more employees), while in the 2009 survey, 22% were small firms, 27% were medium-sized firms, and 51% were large firms. Thus, the size distribution of responding firms is very different between the 2003 survey and the 2009 survey. Moreover, the questions and the choices provided for answers were also quite different between the two surveys, though both surveys are based on the Oslo Manual. Given the considerable differences between the two surveys, we do not pool the micro-data for the two surveys, but use the data separately instead. Therefore, in the following sections, we conduct cross-section analyses for the 2003 and 2009 surveys.[6]

In addition, many of the firms in the services sector did not answer the questions on R&D expenditures and whether they engaged in international activities such as overseas production, sales, and R&D. As we focus on the interaction between innovation and international activities, we restrict our sample to firms in the manufacturing sector. For our empirical analyses below, we eliminate observations for firms with an R&D-sales ratio above 80% and firms that did not provide information on their total sales amount. As a result, we are left with 6,093 observations for 2003 and 1,587 observations for 2009.

2.2 An Overview of Firms' International and Innovation Activities

In this subsection, let us look at the characteristics of Japanese firms' innovation activities based on the results of the JNIS for 2003 and 2009. Specifically, we are interested in the differences in innovation activities across firms with different modes of international activities.

Table 1 provides an overview of the number of firms by industry and by mode of international activities they are engaged in. While the 2003 survey asked firms about the value of their exports, the 2009 survey did not. However, in both surveys, firms were asked in which geographical areas their products were sold or their services provided. Therefore, we do not take exports into account in this paper and classify firms into five categories based on the nature of their overseas activities (if they have any). Specifically, the first category consists of firms which have a production establishment abroad but do not have an establishment for any other activities (Foreign production only). The second category consists of firms which have a production establishment abroad and

[4] For more details on the 2003 survey, see National Institute of Science and Technology Policy (2004).
[5] For more details on the 2009 survey, see National Institute of Science and Technology Policy (2010).
[6] Instead of pooling the entire datasets, we could try to construct a panel consisting of firms that responded to both surveys. Unfortunately, however, there are very few such firms, so that we do not have a sufficient number of observations.

also sell their products or services abroad (Foreign sales and production). The third category consists of firms which sell their products or services abroad but do not have a production establishment abroad (Foreign sales only).[7] The fourth category consists of firms which have an establishment for research and development abroad (Foreign R&D). Firms in this category are likely to either have a production establishment abroad or sell their product or services abroad. The fifth category, finally, consists of firms which do not have any establishment abroad and do not sell their products or services abroad (No foreign activities).

In Table 1, manufacturing industries are further classified into high-tech industries and low-tech industries based on the industry-average R&D intensity. Table 1 indicates that while the industry distribution of firms in the 2003 data and the 2009 data is similar, the distribution of firms by mode of international activities differs somewhat between the two datasets, reflecting the fact that, as mentioned above, the size distribution of firms differs considerably between the two surveys. The share of firms with no foreign activities is much larger in the 2003 data than the 2009 data. It is particularly large in the low-tech industries, where only 16% of firms had any international activities in 2003, although the share for 2009 is about 30%.

INSERT Table 1

Table 2 provides summary statistics regarding the innovation activities of Japanese firms based on the 2003 and the 2009 surveys. Most of the variables in Table 2 are dummy variables that take one if a particular observation applies.

The table indicates that firms with international activities are more likely to innovate than firms without foreign activities. In particular, firms with overseas R&D activities are the most innovative in terms of both innovation inputs and output (that is, in terms of innovation output, the share of firms that realized product or process innovations is the highest for this category of firms, for example, while in terms of innovation inputs, the average R&D intensity is the highest for this category of firms, for example), followed by firms with both sales and production establishments abroad, firms with overseas sales only, and firms with production establishments abroad only. Another notable observation is that firms with foreign R&D are considerably more likely than other firms to have a cooperation agreement regarding innovation with foreign firms and institutions. These firms, moreover, are more likely to receive central government-funded public financial support for innovation activities and to use competitors and universities or government as sources of information. As for the effects of innovation, firms with foreign R&D are more likely to increase the range of goods and services and place emphasis on improving the quality of goods and services than firms with other modes of foreign activities.

[7] Because the survey questionnaire did not ask firms whether they sell their products and/or services abroad by exporting them directly, exporting them indirectly via trading companies, etc., or through sales establishments abroad, but simply asked where their products/services were sold, firms in the "Foreign sales only" category may or may not have their sales establishments abroad.

INSERT Table 2

3. Econometric Specification and Estimation

3.1 Empirical Model

The aim of our empirical investigation is to examine what factors determine whether a firm innovates or not and how important innovation is for a firm. Specifically, we focus on the relationship between a firm's innovation outcomes (i.e., whether a firm innovates a new product or process, or whether new products make up a large amount of sales) and the firm's overseas activities. In the JNIS questionnaire, while some questions are asked to all responding firms, there are many questions which only "innovating" firms have to answer. Innovating firms are those answering that they had developed new or changed products, or new or changed processes in the preceding three years (i.e., 1999-2001 for the 2003 survey and 2006-2008 for the 2009 survey). To address the censoring or selection problems arising due to such a setup of the questionnaire, Mohnen, Mairesse, and Dagenais (2006) employ a generalized tobit model consisting of two equations, where the first one is a probit equation determining whether a firm innovates or not and the second one is a linear regression (or tobit equation) explaining how much the firm innovates. Thus, the second equation of the model in Mohnen, Mairesse, and Dagenais (2006) is estimated only for innovating firms, including various types of information which only innovating firms provided.

However, in this paper, we do not adopt such a two-stage model. Instead, we separately estimate two equations using all the observations. We adopt this approach because the number of observations becomes very small and we do not obtain significant estimation results when we limit our sample to innovating firms only. The reasons why we lose a lot of observations are the following. First, only firms which developed new or changed products, but not firms which developed new or changed processes, were asked about the amount of sales based on innovations. Second, although all the firms were asked about the details of their international activities – i.e., their overseas sales, production, and/or R&D, the region(s) where they sell and/or produce their products, etc. – the number of firms engaged in international activities is quite small. Third, although we tried to estimate the determinants of sales of new-to-the-firm products for innovating firms by employing the Heckman selection model, the estimated coefficient of most explanatory variables and the Mills ratio were not statistically significant.

Therefore, we estimate the following two equations separately for the 2003 and the 2009 data in order to investigate the factors determining whether a firm innovates or not (equation 1) and the factors explaining the quantitative importance of innovation (equation 2):

$$y_{1i} = \begin{cases} 1 & if \quad y_{1i}^{*} = X_i\beta_1 + \varepsilon_1 > 0 \\ 0 & if \quad y_{1i}^{*} = X_i\beta_1 + \varepsilon_1 \leq 0 \end{cases} \tag{1}$$

$$y_{2i} = X_i\beta_2 + \varepsilon_2 \tag{2}$$

where y_{1i}^{*} is a latent innovation variable for firm i measuring the propensity to innovate and y_{1i} is the corresponding observed binary variable, which takes one for innovating firms. y_{2i} represents the innovation output and X_i is a vector of various variables explaining innovation propensity and innovation output. β_1 and β_2 are vectors of parameters to be estimated, and ε_1 and ε_2 are random error terms.

The first innovation variable, y_{1i}, is a dummy variable which takes one for firms that developed new or changed products or processes during the preceding three years. The second innovation variable, y_{2i}, denotes the sales turnover of significantly improved products.[8] Although the innovation intensity, i.e., the share of innovative sales in total sales, can be used as a proxy for innovation output (see, e.g., Mohnen, Mairesse, and Dagenais, 2006; Love and Ganotakis, 2013), we use the sales amount of new products (in logarithm) as our measure of innovation output, for the following two reasons. First, while the 2009 survey asked about the share of new product sales, firms were asked to respond in terms of six ranges, such as <1%, 1-5%, 5-10%, and so on; on the other hand, responses to the same question in the 2003 survey are in exact numbers. Therefore, we cannot employ a linear regression (or tobit equation) for equation (2) in the case of the 2009 data. Second, we wanted to analyze the data from the two surveys in the same framework in order to compare the results and to obtain robust conclusions.[9] Therefore, instead of using the share of innovative sales in total sales, we used the amount of innovative sales, which we obtained by converting the share of new product sales provided in the two surveys into the sales amount of new products by multiplying the share by firms' total sales.[10] We should note, moreover, that a number of firms did not provide an answer to the question about the share of innovative sales and we treat such responses as zero for all firms that did not provide the share of new product sales although they reported to be innovators. We also assume that new product sales are zero for firms that reported not to be innovators.

As for the explanatory variables, X_i, following Mohnen, Mairesse, and Dagenais (2006), we include firm size, membership of an enterprise group, R&D intensity, strength of competition, proximity to basic research, and industry dummies. Firm size, which reflects access to finance, scale economies, and differences in the organization of work, is measured as the firm's total sales amount in logarithm. We use the sales amount in 1999 for the 2003 estimation and that in 2006 for the 2009 estimation.[11] The enterprise group membership dummy is included as an explanatory

[8] Although the survey asked firms about the shares of new-to-the-firm and new-to-the-market products in total turnover, the number of firms which provided an answer regarding the share of new-to-the-market products is very small and we did not obtain significant estimation results when using the sales turnover of new-to-the-market products as the dependent variable. Therefore, our dependent variable y_{2i} denotes the turnover of new-to-the-firm products.

[9] We also estimated equation (2) using the share of new product sales in the case of the 2003 survey and obtained results consistent with those estimated using the sales amount. The results based on the new product sales share are available from the authors upon request.

[10] In the case of the 2009 survey, we use the midpoint of each range for the share of new product sales. Isogawa, Nishikawa, and Ohashi (2012) employ the same strategy to calculate new product sales.

[11] The reason why we use the sales amount rather than the number of employees, which is often used as a proxy for firm size, is that the 2009 survey did not ask about the number of workers (although the 2003 survey did). In the 2009 survey, only the size category (small, medium, or large) for each firm is

variable because firms that are part of a group are expected to benefit from intra-group knowledge spillovers, internal access to finance, and various other synergies, and therefore to be more innovative. For the 2003 estimation, we construct a group membership dummy which takes one for firms that belong to an enterprise group. However, the 2009 survey does not ask a question on group membership, and instead, we use information on interdivisional cooperation and coordination as a proxy for knowledge spillovers. The 2009 survey asked firms whether or not they engaged in interdivisional cooperation, new organization or meetings, or initialized new functional systems to accumulate and share information within the firm. Thus, we construct a dummy variable which takes one for firms which employ such interdivisional cooperation and use it as a proxy for knowledge spillovers within firms in the case of the 2009 estimation. R&D intensity, which is measured as the ratio of R&D expenditure to total sales, is included as a proxy for a firm's innovation inputs. The strength of perceived competition is a dummy variable which, in the case of the 2003 survey, takes one for firms that implemented corporate strategies to offer original products that are different from those of other enterprises. The dummy is based on the assumption that firms implement such strategies when they perceive strong competitive pressure. However, the 2009 survey did not ask any questions regarding the strategies firms implemented and we use a dummy variable regarding market conditions instead. Thus, for 2009, the dummy takes one for firms which answered that products and services in the market became more diversified, which we interpret as indicating that such changes reflect strong competitive pressure. Next, proximity to basic research is also a dummy variable, which takes one for firms answering that universities/other higher education institutes or government/private non-profit research institutes are significant sources of information for innovation. While this information is available for all firms in the 2003 survey, only innovating firms were asked about information sources in the case of the 2009 survey. Assuming that non-innovating firms did not source information from universities/government research institutes, we therefore assigned a value of zero for this variable for all non-innovating firms. Industry dummies are considered to capture technological opportunity conditions, industry-targeted innovation policies, industry-specific demand growth effects, and structural effects such as the intensity of competition.

Moreover, as we focus on the relationship between firms' innovation outcomes and their overseas activities, we include dummy variables which represent the mode of firms' overseas activities. The definition of the mode of foreign activities is the same as that employed in the descriptive analysis in Section 2.2 and we prepare the following four dummy variables: *Foreign production only*, *Foreign sales and production*, *Foreign sales only*, and *Foreign R&D*.

Summary statistics for the explanatory variables for the 2003 and the 2009 data are shown in Tables 3 and 4, respectively.

---

provided. We use the number of employees instead of the sales amount as a proxy for firm size only for the 2003 estimation as a robustness check, and the results are shown in Appendix Tables 1-4, which are very similar to the results based on the sales amount.

INSERT Tables 3 and 4

3.2 Estimation Results

We estimate the above equations (1) and (2) using probit and tobit estimation, respectively, and the estimation results are shown in Tables 5 to 8. Tables 5 and 6 show the marginal effects at the means of the explanatory variables based on the probit estimation results for the 2003 and the 2009 data, respectively. Tables 7 and 8 show the marginal effects at the means of the explanatory variables based on the tobit estimation results for the 2003 and the 2009 data, respectively.

INSERT Tables 5, 6, 7, and 8

The results in Tables 5 to 8 confirm that firm size, group membership (interdivisional cooperation within a firm for the 2009 data), and all the structural variables (R&D intensity, perceived competition, and proximity to basic research) positively affect innovation outcomes, as expected. In the case of the 2003 data, the variables representing perceived competition and proximity to basic research have a large marginal effect in both the probit and tobit models, suggesting that these factors are important for innovation. In addition, the relatively large marginal effect of the interdivisional cooperation variable in the 2009 result implies that intra-firm knowledge spillovers and organizational reform effects to promote knowledge spillovers are important for innovation. As for the modes of international activities, the coefficients on the four dummy variables are positive in all cases except one, although they are not statistically significant in some cases. Moreover, the magnitudes of the estimated marginal effects are quite different between the 2003 results and the 2009 results, probably reflecting the different size distributions of sample firms in the two surveys. Nevertheless, the results suggest that firms with any type of international activities are more likely to innovate, implying the existence of a positive interplay between international activities and domestic innovation.

3.3 Accounting for Innovation

The descriptive statistics above suggested that firms with international activities tend to be larger, more R&D-intensive, face fiercer competition, and be more likely to utilize basic research institutes as information sources. Moreover, according to the probit and tobit estimation results above, after controlling for various firm characteristics, firms with any mode of international activities tend to have a higher probability of being innovators and a larger amount of innovative sales.

In this section, we provide a decomposition of the innovation performance for each of the firm groups with different modes of international activities in terms of “structural effects” (the effects of the main explanatory factors of innovation that we have been able to consider) and of innovativity, based on the accounting for innovation framework proposed by Mairesse and Mohnen (2001, 2002) and Mohnen, Mairesse, and Dagenais (2006). “Innovativity” is defined as that part of innovation that is not explained by a model incorporating usual predictive variables

such as firm size, R&D intensity, and industry. In other words, "innovativity" is the residual from an innovation production function, corresponding to the idea of total factor productivity (TFP) in standard production analysis. "Innovativity" or innovativeness is thus to innovation what TFP is to production (Mairesse and Mohnen, 2002).

In Tables 9 and 10, we present the results of applying the innovation accounting framework to compare the propensity to innovate (i.e., whether a firm innovates or not) for firms with different modes of international activities based on the 2003 survey and the 2009 survey, respectively. Tables 11 and 12 show the result of innovation accounting for new-to-the-firm sales based on the 2003 survey and the 2009 survey, respectively.[12]

We account for the observed propensity to innovate (or observed new-to-the-firm sales) in terms of the expected propensity (or expected sales) explained by the underlying model and innovativity which is unexplained by the model. We also decompose the expected propensity or sales into an overall average propensity or overall average sales and four categories of "structural effects" corresponding to the explanatory variables in our model, that is, industry effects, size and group effects, R&D effects, and environmental effects (perceived competition and proximity to basic research). For each group of firms in a given sample, we start from the overall average of observed innovation propensity (or sales) for the full sample (column 1). We then compute the expected propensity to innovate (or new-to-the-firm sales) for each group by taking a linear approximation of the expected propensity (or sales) around the overall observed averages of the different variables in the model. The rows labeled "Average" in Tables 9 to 12 make it clear that this decomposition is to be interpreted in terms of the effects of the mode of international activities relative to the full sample effects (deviation from the full sample effects). "Innovativity" is computed as the difference between the observed and the expected average innovation propensity (or sales) in each group of firms, and is to be viewed as the innovativeness arising from international activities relative to overall innovativeness.

INSERT Tables 9, 10, 11, and 12

As for the propensity to innovate (Tables 9 and 10), a significant part of the observed propensity is explained by the underlying model (i.e., structural effects). Moreover, the estimated magnitude or importance of innovativeness for each type of firms differs depending on whether we use data for firms in high-tech industries only, low-tech industries only, or firms in all industries. Therefore, the relationship between innovativity and the mode of international activities is not straightforward in the case of the propensity to innovate, probably because our measure of the propensity to innovate does not take account of the "size" or importance of the innovation and because product innovation and process innovation are not distinguished.

However, in the case of the amount of sales of innovative products (Tables 11 and 12), both the 2003 and the 2009 results suggest that a significant part of the observed sales is not explained by

[12] For a detailed explanation of the decomposition, see Appendix A in Mohnen, Mairesse, and Dagenais (2006).

the structural effects and that innovativity explains a large part of the advantage in observed new-to-the-firm sales of firms with international activities. In particular the conspicuous advantage in observed new-to-the-firm sales for firms with R&D establishments abroad can be explained by innovativity. For example, in the lower panel of Table 11, the observed amount of sales of innovative products for firms with foreign R&D establishments is 7.3 (in logarithm) compared to an average sales amount of 2.5 (in logarithm), which means that the amount of innovative sales for firms with R&D establishments abroad is on average 120 times as large as that for the average firm. As the expected sales amount (i.e., the sales amount explained by the structural effects) for firms with R&D establishments abroad is 7.3 times as large as that for the average firm (4.5 in logarithm versus 2.5 in logarithm), the difference between the observed sales and the expected sales is huge and this huge difference is attributable to innovativity. The same panel shows that firms with R&D establishments abroad have the highest innovativity, followed, in that order, by firms with overseas sales and production establishments abroad, firms with overseas sales only, firms with production establishments abroad only, and firms without foreign activities. This ranking is also found in the 2009 results in Table 12. Similarly, in the lower panel of Table 12, the amount of innovative sales for firms with R&D establishments abroad is on average 14 times as large as that for the average firm (5.0 in logarithm versus 2.3 in logarithm). The expected sales amount for the former is 4.5 times as large as that for the latter, suggesting that, again, the large difference between the observed sales and the expected sales for firms with R&D establishments abroad (3.8 in logarithm versus 2.3 in logarithm) is attributable to innovativity.

The results can be interpreted as follows. First, firms with international activities, particularly firms with R&D establishments abroad, tend to be larger, more R&D intensive, face fiercer competition, and are more likely to utilize basic research institutes as information sources. Although such structural effects explain a significant part of the high propensity to innovate and the large amount of sales of innovative products for firms with international activities, "innovativity," i.e., innovation efficiency, also explains a significant part of the advantage in the sales of innovative products of such firms. Particularly firms with R&D establishments abroad and firms with both overseas sales and production establishments abroad appear to have a considerable innovativity advantage.

The results suggest that firms with international activities are able to develop new/changed products of higher value or to sell their new/changed products in larger volumes not only because of structural effects, i.e., the usual predictive variables, but also because of innovativity which is not explained by the structural factors. This raises the question what factors underlie the high innovativity of firms with international activities. Table 2 above showed that the share of firms which have a cooperation agreement for innovation with other firms and institutions is much higher for firms with international activities. In particular, the share of firms which cooperate with foreign firms and institutions is considerably higher for firms with international activities. For example, in 2003, 7–36% of firms with international activities cooperated with foreign firms and institutions, although the share varied across firms with different modes of international activities, while only 1% of firms without any foreign activities cooperated with foreign firms and

institutions. Moreover, in Table 2, the share of firms which utilize various information sources is much larger for firms with international activities than those without.

Based on these observations gleaned from Table 2, we conjecture that utilizing foreign firms and/or commercial or public research laboratories as information sources and/or innovation partners enables firms with international activities to leverage their innovations and reach larger volumes of sales of innovative products. Table 13 provides a breakdown of the number of firms not only in terms of the mode of international activities they engage in but also in terms of the various types of innovation partners they cooperate with. For example, in the top left cell in Panel (a), 13 firms which have only production establishments abroad have other domestic enterprises within the same enterprise group as an innovation partner. Similarly, 6 firms which have only production establishments abroad have other enterprises abroad within the same enterprise group as an innovation partner. Table 13 suggests that firms with R&D establishments abroad are more likely to have an innovation partner abroad. A significant share of such firms has competitors, commercial R&D suppliers, and/or public education or research institutes in foreign countries as innovation partners. Firms with overseas sales tend to have foreign clients and customers as innovation partners, suggesting that these firms utilize information from such partners to develop new/changed products in a way that fits the local market.

INSERT Table 13

4. Concluding Remarks

In this paper, we investigated differences in innovation activities between firms with international activities and firms without such activities, utilizing the firm-level data underlying the Japanese National Innovation Surveys for 2003 and 2009. We quantitatively examined the factors which account for differences in innovation output depending on the mode of firms' international activities. Further, in order to examine the advantages in innovation efficiency of firms with international activities, we employed the innovation accounting framework proposed by Mairesse and Mohnen (2001, 2002) and Mohnen, Mairesse, and Dagenais (2006) and decomposed firms' innovation performance into "structural effects" (the effects of factors which are considered to affect innovation performance such as firm size, R&D input, competition, and so on) and "innovativity," which is that part of innovation that is not explained by the structural effects and can be compared to TFP in production.

We found that internationally active firms use more innovation inputs and generate more innovation output. In particular, firms with R&D establishments abroad showed the best innovation performance, followed by firms with both sales and production establishments abroad, firms with overseas sales only, and firms with production establishments abroad only. Based on the innovation accounting framework, we found that, as expected, a significant part of the higher innovation performance of firms with international activities can be explained by their greater

intra-group or intra-firm knowledge spillovers, R&D intensity, perceived competitive pressure, and proximity to basic research. Moreover, although engagement in international activities does not explain differences in the probability that firms are innovators, if firms are innovators, such activities greatly increase the amount of sales associated with innovations. Given that firms with international activities differ significantly from domestic firms in terms of market strategies, information sources, innovation partners, and so on, our results suggest that firms with international activities achieve better innovation performance by utilizing foreign firms and/or commercial or public research laboratories as information sources and/or innovation partners.

Based on these results, we conjecture that firms with a wider range of international activities have more opportunities to learn from a variety of information sources and innovation partners about preferences in foreign markets and technologies relevant for market success, allowing them to achieve greater sales from innovation. These greater innovative sales, in turn, may explain the higher productivity of internationalized firms observed in several preceding empirical studies, i.e., the learning-from-international-markets effect.

However, several caveats regarding the analysis presented in this paper should be mentioned. Although we found a positive relationship between international activities and innovation efficiency, we did not rigorously examine the reasons for this positive relationship. We conjecture that differences in innovative sales between domestic firms and internationalized firms are one potential factor behind the positive relationship and that differences in information sources and innovation partners are likely to matter for differences in sales of innovative products. However, other factors, such as a degree of competition and incentives for and/or the aims of innovation may differ between domestic firms and internationalized firms. These are issues that need be examined in greater detail for a deeper understanding of learning-from-international markets effects. In addition, the analytical framework of this paper did not allow us to examine the causal relationship between internationalization and innovation. Further investigating this causal relationship represents another important research issue, given the possibility that firms make decisions on their innovation and internationalization strategies based on different incentives and for different purposes.

References

Aw, Bee Yan, Mark J. Roberts, and Tor Winston (2007) “Export Market Participation, Investments in R&D and Worker Training, and the Evolution of Firm Productivity,” *The World Economy*, 30(1), pp. 83–104.

Aw, Bee Yan, Mark J. Roberts, and Daniel Yi Xu (2011) “R&D Investment, Exporting, and Productivity Dynamics,” *American Economic Review,* 101(4), pp. 1312–44.

Blind, Knut and Andre Jungmittag (2004) “Foreign Direct Investment, Imports and Innovation in the Service Industry,” *Review of Industrial Organization*, 25, pp. 205–227.

Castellani, Davide and Antonello Zanfei (2007) “Internationalisation, Innovation and Productivity: How Do Firms Differ in Italy?” *The World Economy*, 30(1): 151–176.

Crépon, Bruno, Emmanuel Duguet, and Jacques Mairesse (1998) “Research, Innovation and

Productivity: An Econometric Analysis at the Firm Level," *Economics of Innovation and New Technology*, 7(2), pp. 115–158.

Criscuolo, Chiara, Jonathan E. Haskel, and Matthew J. Slaughter (2010) "Global Engagement and the Innovation Activities of Firms," *International Journal of Industrial Organization*, 28, pp. 191–202.

Damijan, Jože, Črt Kostevc, and Sašo Polanec (2010) "From Innovation to Exporting or Vice Versa?" *The World Economy*, 33(3), pp. 374–398.

De Loecker, Jan (2007) "Do Exports Generate Higher Productivity? Evidence from Slovenia," *Journal of International Economics*, 73(1), pp. 69–98.

Fukao, Kyoji and Hyeog Ug Kwon (2006) "Why Did Japan's TFP Growth Slow Down in the Lost Decade? An Empirical Analysis Based on Firm-Level Data of Manufacturing Firms," *The Japanese Economic Review*, 57(2), pp. 195–228.

Girma, Sourafel, Holger Görg, and Aoife Hanley (2008) "R&D and Exporting: A Comparison of British and Irish Firms," *Review of World Economics*, 144, pp. 750–773.

Girma, Sourafel, David Greenaway, and Richard Kneller (2004) "Does Exporting Lead to Better Performance? A Microeconometric Analysis of Matched Firms," *Review of International Economics*, 12, pp. 855–866.

Griliches, Zvi (1998) *R&D and Productivity*, University of Chicago Press, Chicago

Isogawa, Daiya, Kohei Nishikawa, and Hiroshi Ohashi (2012) "New-to-Market Product Innovation and Firm Performance: Evidence from a Firm-Level Innovation Survey in Japan," *RIETI Discussion Paper Series*, No. 12-E-077, Research Institute of Economy, Trade and Industry.

Ito, Keiko (2011) "Sources of Learning-by-Exporting Effects: Does Exporting Promote Innovation?" *FREIT Working Paper Series*, No. 295, Forum for Research in Empirical International Trade.

Jaffe, Adam and Manuel Trajtenberg (2002) *Patents, Citations, and Innovations: A Window on the Knowledge Economy*, MIT Press, Cambridge, MA.

Kimura, Fukunari and Kozo Kiyota (2006) "Exports, FDI, and Productivity: Dynamic Evidence from Japanese Firms," *Review of World Economics*, 142(4), pp. 695–719.

Kwon, Hyeog Ug, Kyoji Fukao, and YoungGak Kim (2008) "Inobeshon to Seisansei Josho: Zenkoku Inobeshon Chosa to Kigyo Katsudo Kihon Chosa Kohyo Deta niyoru Jissho Bunseki [Innovation and Productivity Growth: An Empirical Analysis Based on Micro Data of the Basic Survey of Business Structure and Activity and the Japanese National Innovation Survey]," *Global COE Hi-Stat Discussion Paper Series*, No. 2, Institute of Economic Research, Hitotsubashi University (in Japanese).

Love, James H. and Panagiotis Ganotakis (2013) "Learning by Exporting: Lessons from High-Technology SMEs," *International Business Review*, 22(1), pp. 1–17.

Mairesse, Jacques and Pierre Mohnen (2001) "To Be or Not To Be Innovative: An Exercise in Measurement," *NBER Working Paper*, No. 8644, National Bureau of Economic Research.

Mairesse, Jacques and Pierre Mohnen (2002) "Accounting for Innovation and Measuring

Innovativeness: An Illustrative Framework and an Application," *American Economic Review*, 92(2), pp. 226–230.

Mohnen, Pierre, Jacques Mairesse, and Marcel Dagenais (2006) "Innovativity: A Comparison Across Seven European Countries," *Economics of Innovation and New Technology*, 15(4-5), pp. 391-413.

National Institute of Science and Technology Policy (2004) "Statistics on Innovation in Japan: Report on the Japanese National Innovation Survey 2003," *Research Material* No. 110, National Institute of Science and Technology Policy, First Theory-Oriented Research Group, Ministry of Education, Culture, Sports, Science and Technology.

National Institute of Science and Technology Policy (2010) "Report on the Japanese National Innovation Survey 2009," *NISTEP Report* No. 144, National Institute of Science and Technology Policy, First Theory-Oriented Research Group, Ministry of Education, Culture, Sports, Science and Technology.

Romer, Paul M. (1990) "Endogenous Technological Change," *Journal of Political Economy*, 98(5), pp. S71-S102.

Roper, Stephen and James H. Love (2002) "Innovation and Export Performance: Evidence from the UK and German Manufacturing Plants," *Research Policy*, 31(7), pp. 1081–1102.

Salomon, Robert M. and J. Myles Shaver (2005) "Learning by Exporting: New Insights from Examining Firm Innovation," *Journal of Economics and Management Strategy*, 14, pp. 431–460.

Wagner, Joachim (2006) "International Firm Activities and Innovation: Evidence from Knowledge Production Functions for German Firms," *Working Paper Series in Economics*, No. 25, University of Lüneburg.

Wagner, Joachim (2007) "Exports and Productivity: A Survey of the Evidence from Firm-Level Data," *The World Economy*, 30(1), pp. 60–82.

Wagner, Joachim (2012) "International Trade and Firm Performance: A Survey of Empirical Studies since 2006," *Review of World Economics*, 148(2), pp. 235–267.

Yashiro, Naomitsu and Daisuke Hirano (2010) "Anatomy of Learning-from-Exporting: Role of Foreign Knowledge Acquisition," *RIETI Discussion Paper Series*, No. 10-E-053, Research Institute of Economy, Trade and Industry.

Table 1. Number of Firms by Industry and Mode of International Activities

(a) 2003

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Total	(%)
High-tech industries							
Motor vehicles	15	36	38	16	414	519	(23.3)
Chemical products	4	29	104	22	320	479	(21.5)
Machinery and equipment	2	41	83	15	207	348	(15.6)
Electronics	26	77	142	43	597	885	(39.7)
Total	47	183	367	96	1,538	2,231	(100.0)
(%)	(2.1)	(8.2)	(16.5)	(4.3)	(68.9)	(100.0)	
Low-tech industries							
Food	9	13	41	10	570	643	(16.6)
Textiles	53	21	21	20	405	520	(13.5)
Wood	12	9	25	4	658	708	(18.3)
Plastic products	19	42	28	8	391	488	(12.6)
Non-metallic products	4	13	21	1	381	420	(10.9)
Metal products	12	37	66	8	610	733	(19.0)
Not elsewhere classified	34	11	28	16	261	350	(9.1)
Total	143	146	230	67	3,276	3,862	(100.0)
(%)	(3.7)	(3.8)	(6.0)	(1.7)	(84.8)	(100.0)	

(b) 2009

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Total	(%)
High-tech industries							
Motor vehicles	8	17	25	6	135	191	(20.7)
Chemical products	2	10	48	6	96	162	(17.6)
Machinery and equipment	2	35	60	6	82	185	(20.1)
Electronics	12	56	73	22	221	384	(41.6)
Total	24	118	206	40	534	922	(100.0)
(%)	(2.6)	(12.8)	(22.3)	(4.3)	(57.9)	(100.0)	
Low-tech industries							
Food	1	6	14	2	122	145	(15.5)
Textiles	16	13	16	6	70	121	(12.9)
Wood	3	12	6	3	145	169	(18.1)
Plastic products	7	15	16	12	69	119	(12.7)
Non-metallic products	2	8	8	2	52	72	(7.7)
Metal products	6	29	43	7	142	227	(24.3)
Not elsewhere classified	6	11	7	8	51	83	(8.9)
Total	41	94	110	40	651	936	(100.0)
(%)	(4.4)	(10.0)	(11.8)	(4.3)	(69.6)	(100.0)	

Table 2. Characteristics of Innovation by Mode of International Activities: Means of Variables

(a) 2003

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Knowledge/Innovation						
R&D intensity (Internal R&D expenditure/sales in 2001) (%)	0.630	1.692	1.209	1.991	0.369	0.574
Innovator (Product and/or process innovation) [0/1]	0.416	0.647	0.528	0.669	0.235	0.303
Product innovation [0/1]	0.374	0.605	0.491	0.638	0.188	0.258
Process innovation [0/1]	0.221	0.374	0.241	0.460	0.121	0.159
Share of sales with new products (Only for firms with product innovation) (%)	8.505	11.322	9.147	14.933	3.710	5.104
Labor productivity in 2001 (Sales per employee in million yen)	29.135	35.670	86.047	46.952	27.507	34.254
Cooperation for innovation with other firms and institutions [0/1]	0.137	0.353	0.240	0.442	0.073	0.116
Cooperation for innovation with foreign firms and institutions (Only for firms with cooperation for innovation) [0/1]	0.084	0.137	0.074	0.362	0.010	0.035
Public support						
Local funding [0/1]	0.079	0.100	0.089	0.117	0.040	0.051
National funding [0/1]	0.026	0.122	0.094	0.264	0.027	0.045
Effects regarding product innovation						
Increased the range of goods and services: medium or high importance [0/1]	0.258	0.432	0.402	0.515	0.137	0.193
Expanded the market or increased market share: medium or high importance [0/1]	0.200	0.389	0.327	0.460	0.109	0.157
Improved quality in goods or services: medium or high importance [0/1]	0.242	0.438	0.384	0.546	0.145	0.198
Effects regarding process innovation						
Improved production flexibility: medium or high importance [0/1]	0.142	0.340	0.263	0.393	0.105	0.142
Increased production capacity: medium or high importance [0/1]	0.179	0.307	0.248	0.387	0.108	0.142
Reduced labor costs: medium or high importance [0/1]	0.184	0.295	0.216	0.362	0.094	0.127
Reduced materials and energy usage: medium or high importance [0/1]	0.126	0.264	0.164	0.307	0.066	0.095

(a) 2003 --- *continued* ---

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Other effects						
Improved environment and impact or health and safety aspects: medium or high importance [0/1]	0.132	0.298	0.189	0.337	0.091	0.120
Satisfied regulations or standards: medium or high importance [0/1]	0.095	0.274	0.169	0.282	0.076	0.102
Sources of information						
Internal sources within the group [0/1]	0.400	0.623	0.549	0.663	0.227	0.297
Suppliers as source of information [0/1]	0.295	0.508	0.424	0.540	0.173	0.229
Customers as source of information [0/1]	0.268	0.532	0.481	0.552	0.169	0.233
Competitors as source of information [0/1]	0.184	0.398	0.347	0.454	0.122	0.169
Universities or government as source of information [0/1]	0.142	0.368	0.281	0.454	0.084	0.130
Appropriability conditions						
Formal protection [0/1]	0.253	0.492	0.372	0.521	0.107	0.169
Strategic protection [0/1]	0.311	0.562	0.487	0.613	0.184	0.249
Firm size						
10-49 employees [0/1]	0.368	0.106	0.305	0.276	0.541	0.482
50-249 employees [0/1]	0.426	0.337	0.430	0.209	0.358	0.362
250 or more employees [0/1]	0.205	0.556	0.265	0.515	0.102	0.156
Observations	190	329	597	163	4814	6093

(b) 2009

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Knowledge/Innovation						
R&D intensity (Internal R&D expenditure/Sales in 2001) (%)	0.542	1.269	1.328	2.061	0.537	0.840
Innovator (Product and/or process innovation) [0/1]	0.724	0.855	0.808	0.899	0.568	0.667
Product innovation [0/1]	0.483	0.672	0.593	0.739	0.328	0.442
Process innovation [0/1]	0.603	0.763	0.695	0.754	0.481	0.572
Amout of sales with new products (Million yen; only firms with product innovation)	4528.952	3663.387	1469.478	28234.500	428.910	2364.797
Cooperation for innovation with other firms and institutions [0/1]	0.414	0.694	0.596	0.739	0.299	0.425
Cooperation for innovation with foreign firms and institutions (Only for firms with cooperation for innovation) [0/1]	0.224	0.333	0.189	0.580	0.023	0.122
Public support						
Local funding [0/1]	0.052	0.161	0.099	0.072	0.070	0.086
National funding [0/1]	0.052	0.183	0.152	0.217	0.062	0.100
Effects regarding product innovation (Only for firms with product innovation)						
Increased the range of goods and services: medium or high importance [0/1]	0.345	0.511	0.404	0.594	0.201	0.298
Expanded the market or increased market share: medium or high importance [0/1]	0.207	0.344	0.291	0.406	0.145	0.210
Improved quality in goods or services: medium or high importance [0/1]	0.310	0.511	0.430	0.478	0.203	0.298
Effects regarding process innovation (Only for firms with process innovation)						
Improved production flexibility: medium or high importance [0/1]	0.310	0.366	0.404	0.391	0.221	0.284
Reduced labor costs: medium or high importance [0/1]	0.172	0.199	0.175	0.174	0.082	0.121
Reduced materials and energy usage: medium or high importance [0/1]	0.138	0.177	0.129	0.174	0.072	0.102

(b) 2009 --- *continued* ---

	Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Other effects (Only for firms with product and/or process innovation)						
Improved environment and impact or health and safety aspects: medium or high importance [0/1]	0.190	0.435	0.341	0.319	0.193	0.255
Satisfied regulations or standards: medium or high importance [0/1]	0.224	0.403	0.447	0.522	0.240	0.310
Sources of information						
Internal sources within the group [0/1]	0.362	0.683	0.579	0.652	0.307	0.420
Suppliers as source of information [0/1]	0.431	0.661	0.583	0.652	0.313	0.424
Customers as source of information [0/1]	0.431	0.613	0.530	0.594	0.261	0.374
Competitors as source of information [0/1]	0.259	0.290	0.219	0.362	0.134	0.183
Universities or government as source of information [0/1]	0.190	0.462	0.364	0.435	0.139	0.234
Appropriability conditions						
Formal protection [0/1]	0.259	0.511	0.434	0.522	0.156	0.270
Strategic protection [0/1]	0.517	0.548	0.563	0.638	0.270	0.383
Firm size						
10-49 employees [0/1]	0.138	0.038	0.146	0.116	0.294	0.222
50-249 employees [0/1]	0.328	0.124	0.255	0.145	0.349	0.295
250 or more employees [0/1]	0.534	0.839	0.599	0.739	0.357	0.483
Observations	58	186	302	69	972	1587

Notes: Items with [0/1] are based on dummy variables which take one for firms that apply and zero, otherwise. Therefore, the mean values shown in the table for such items indicate the share of firms that apply. Labor productivity cannot be calculated for 2009.

Table 3. Summary Statistics for 2003

Variables		Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Number of firms	High-tech (H)	47	183	367	96	1,538	2,231
	Low-tech (L)	143	146	230	67	3,276	3,862
	Total	190	329	597	163	4,814	6,093
Percent of high-tech firms		24.7	55.6	61.5	58.9	31.9	36.6
Average no. of workers in 1999	H	341	1,442	317	6,512	146	557
	L	131	845	237	1,034	108	161
Average sales in 1999 (million yen)	H	14,336	90,781	13,132	316,415	4,443	26,587
	L	4,507	49,829	11,732	83,952	2,426	6,264
Percent belonging to a group	H	51.1	58.5	35.4	52.1	29.2	34.1
	L	23.8	47.3	29.1	35.8	24.3	25.7
Average R&D/sales in 2001 in percent	H	1.6	2.3	1.5	3.0	0.6	1.0
	L	0.3	1.0	0.8	0.6	0.3	0.3
Percent of innovating firms	H	42.6	71.6	54.5	78.1	26.8	37.6
	L	41.3	56.2	50.0	50.7	22.0	26.2
Percent of firms indicating R&D expenditure in 2001	H	34.0	57.9	49.9	62.5	20.1	30.2
	L	26.6	49.3	40.9	38.8	15.0	18.6
Average share of new-to-firm sales in percent, for innovating firms	H	24.7	19.7	19.7	20.7	15.8	18.3
	L	21.4	17.5	16.2	20.7	14.2	15.2
Percent of firms that perceived increased competition	H	36.2	55.7	54.8	74.0	26.5	35.8
	L	42.7	50.7	48.7	52.2	25.9	29.3
Percent of firms with proximity to basic research	H	17.0	39.9	28.3	59.4	10.0	17.7
	L	11.9	31.5	24.8	25.4	6.7	9.3

Table 4. Summary Statistics for 2009

Variables		Foreign production only	Foreign sales and production	Foreign sales only	Foreign R&D	No foreign activities	Overall average
Number of firms	High-tech (H)	20	99	197	37	437	790
	Low-tech (L)	38	87	105	32	535	797
	Total	58	186	302	69	972	1587
Percent of high-tech firms		34.5	53.2	65.2	53.6	45.0	49.8
Average sales in 2006 (million yen)	H	21,672	48,302	15,566	142,949	7,304	21,219
	L	8,622	58,595	96,131	121,169	8,695	30,173
Percent of firms promoting	H	80.0	85.9	79.7	86.5	49.3	66.7
interdivisional cooperation	L	60.5	88.5	80.0	78.1	50.8	62.2
Average R&D/sales in 2006 in percent	H	0.8	1.7	1.5	2.5	0.9	1.2
	L	0.4	0.8	0.9	1.5	0.3	0.5
Percent of firms indicating R&D	H	65.0	84.8	79.7	78.4	81.0	80.6
expenditure in 2006	L	73.7	79.3	84.8	81.3	79.3	79.8
Percent of innovating firms	H	90.0	84.8	80.7	89.2	56.8	68.6
	L	63.2	86.2	81.0	90.6	56.8	64.9
Average share of new-to-market sales in	H	13.3	7.7	13.9	19.7	9.7	11.6
percent	L	8.0	5.6	8.9	7.8	6.9	7.1
Percent of firms that perceived increased	H	70.0	67.7	64.5	70.3	48.1	56.2
competition	L	68.4	65.5	62.9	59.4	55.5	58.3
Percent of firms with proximity to basic	H	10.0	38.4	32.5	43.2	13.5	22.7
research	L	21.1	43.7	34.3	37.5	12.0	19.8

Table 5. Estimated Marginal Effects for the Probit Model of Innovation: 2003

	High-tech industries (HT)			Low-tech industries (LT)			All mfg. industries (HT+LT)		
	dy/dx	sd		dy/dx	sd		dy/dx	sd	
Log of sales (1999)	0.037	0.008	***	0.023	0.005	***	0.029	0.004	***
Group membership	0.094	0.029	***	0.030	0.018	*	0.051	0.016	***
R&D/sales	0.129	0.011	***	0.027	0.004	***	0.076	0.004	***
Perceived competition	0.303	0.026	***	0.309	0.018	***	0.310	0.015	***
Proximity to basic research	0.389	0.036	***	0.433	0.032	***	0.416	0.024	***
Foreign production only	0.034	0.090		0.136	0.045	***	0.124	0.041	***
Foreign sales and production	0.190	0.054	***	0.138	0.049	***	0.173	0.037	***
Foreing sales only	0.074	0.036	*	0.140	0.036	***	0.103	0.025	***
Foreign R&D	0.131	0.079		0.121	0.064	*	0.129	0.051	**
Motor vehicles	0.017	0.040					-0.040	0.034	
Chemical products							-0.041	0.035	
Machinery and equipment	0.061	0.045					-0.004	0.040	
Electronics	0.102	0.035	**				0.039	0.034	
Food				-0.040	0.029		-0.045	0.032	
Textiles				-0.043	0.029		-0.051	0.033	
Wood				0.025	0.031		0.025	0.035	
Plastic products				0.046	0.034		0.043	0.038	
Non-metallic products				-0.043	0.028		-0.055	0.031	
Metal products				-0.065	0.030	*	-0.078	0.034	**
Not elsewhere classified									
Obs.	2231			3862			6093		
R_2	0.3734			0.2426			0.3122		
LR chi2	1102.9	***		1076.98	***		2334.61	***	

* Significant at 10%, ** at 5%, *** at 1%.

Table 6. Estimated Marginal Effects for the Probit Model of Innovation: 2009

	High-tech industries (HT)		Low-tech industries (LT)		All mfg. industries (HT+LT)	
	dy/dx	sd	dy/dx	sd	dy/dx	sd
Log of sales (2006)	0.025	0.011 **	0.028	0.011 **	0.025	0.008 ***
Interdivisional cooperation	0.315	0.041 ***	0.313	0.041 ***	0.318	0.029 ***
R&D/sales	0.011	0.007	0.035	0.023	0.014	0.007 *
Perceived competition	0.184	0.035 ***	0.150	0.038 ***	0.169	0.026 ***
Proximity to basic research	0.261	0.031 ***	0.308	0.033 ***	0.287	0.022 ***
Foreign production only	0.200	0.041 **	-0.019	0.087	0.074	0.056
Foreign sales and production	0.046	0.055	0.083	0.064	0.068	0.042
Foreing sales only	0.053	0.041	0.060	0.057	0.062	0.033 *
Foreign R&D	0.113	0.069	0.187	0.064 *	0.155	0.046 **
Motor vehicles	0.083	0.046			-0.226	0.093 **
Chemical products					-0.178	0.098 *
Machinery and equipment	0.077	0.041 *			-0.121	0.094
Electronics	0.040	0.050			-0.126	0.082
Food			-0.043	0.091	-0.038	0.087
Textiles			-0.226	0.099 **	-0.229	0.100 **
Wood			-0.248	0.095 **	-0.243	0.096 **
Plastic products			-0.272	0.103 **	-0.259	0.103 **
Non-metallic products			-0.153	0.090 *	-0.134	0.089
Metal products			-0.394	0.107 ***	-0.382	0.108 ***
Not elsewhere classified						
Obs.	790		797		1587	
R_2	0.3116		0.2991		0.3019	
LR chi2	306.36 ***		309.11 ***		609.47 ***	

* Significant at 10%, ** at 5%, *** at 1%.

Table 7. Estimated Marginal Effects for the Tobit Model of Innovation: 2003

	High-tech industries (HT)			Low-tech industries (LT)			All mfg. industries (HT+LT)		
	dy/dx	sd		dy/dx	sd		dy/dx	sd	
Log of sales (1999)	0.370	0.048	***	0.155	0.031	***	0.227	0.026	***
Group membership	0.368	0.177	*	0.108	0.110		0.206	0.094	**
R&D/sales	0.148	0.021	***	0.094	0.015	***	0.111	0.012	***
Perceived competition	2.342	0.179	***	1.863	0.105	***	2.036	0.092	***
Proximity to basic research	1.809	0.216	***	1.523	0.144	***	1.590	0.120	***
Foreign production only	0.550	0.549		0.831	0.222	***	0.836	0.220	***
Foreign sales and production	1.070	0.290	***	0.766	0.220	***	0.884	0.169	***
Foreing sales only	0.948	0.218	***	0.680	0.175	***	0.773	0.131	***
Foreign R&D	0.518	0.389		0.762	0.306	**	0.616	0.228	**
Motor vehicles	-0.412	0.258					-0.454	0.229	*
Chemical products							-0.182	0.224	
Machinery and equipment	0.065	0.266					-0.126	0.240	
Electronics	0.409	0.215	*				0.142	0.202	
Food				-0.296	0.192		-0.386	0.219	*
Textiles				-0.368	0.202	*	-0.436	0.231	*
Wood				0.006	0.188		-0.047	0.214	
Plastic products				0.127	0.196		0.117	0.223	
Non-metallic products				-0.486	0.190	**	-0.610	0.216	**
Metal products				-0.449	0.218	*	-0.576	0.248	**
Not elsewhere classified									
Obs.	2231			3862			6093		
R_2	0.1227			0.1061			0.117		
LR chi2	879.86	***		956.06	***		1903.59	***	

* Significant at 10%, ** at 5%, *** at 1%.

Table 8. Estimated Marginal Effects for the Tobit Model of Innovation: 2009

	High-tech industries (HT)			Low-tech industries (LT)			All mfg. industries (HT+LT)		
	dy/dx	sd		dy/dx	sd		dy/dx	sd	
Log of sales (2006)	0.486	0.059	***	0.431	0.054	***	0.460	0.040	***
Interdivisional cooperation	1.311	0.230	***	1.171	0.202	***	1.250	0.152	***
R&D/sales	0.059	0.027	*	0.202	0.075	**	0.072	0.025	***
Perceived competition	0.899	0.191	***	0.526	0.180	**	0.711	0.131	***
Proximity to basic research	1.313	0.208	***	1.486	0.206	***	1.414	0.146	***
Foreign production only	0.454	0.564		0.412	0.380		0.452	0.319	
Foreign sales and production	0.423	0.282		0.386	0.272		0.425	0.196	**
Foreing sales only	0.590	0.220	**	0.156	0.251		0.445	0.164	**
Foreign R&D	0.752	0.406	*	0.792	0.405	*	0.829	0.286	***
Motor vehicles	-0.663	0.310	*				-1.420	0.348	***
Chemical products							-0.756	0.347	**
Machinery and equipment	0.215	0.287					-0.540	0.334	
Electronics	0.312	0.253					-0.461	0.305	
Food				-0.047	0.339		-0.145	0.348	
Textiles				-0.532	0.352		-0.618	0.366	
Wood				-0.746	0.344	**	-0.848	0.354	**
Plastic products				-0.932	0.356	**	-1.029	0.369	**
Non-metallic products				-0.855	0.321	**	-0.928	0.327	**
Metal products				-1.057	0.412	**	-1.130	0.426	**
Not elsewhere classified									
Obs.	790			797			1587		
R_2	0.1377			0.1378			0.1366		
LR chi2	390.17	***		377.91	***		762.04	***	

* Significant at 10%, ** at 5%, *** at 1%.

Table 9. Accounting for Innovation: Propensity to Innovate 2003

Foreign activities	Average firm's propensity	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected propensity	Propensity innovativity	Observed propensity
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	0.376	0.011	0.019	0.075	-0.002	0.103	0.479	-0.054	0.426
Foreign sales and production	0.376	0.006	0.072	0.168	0.147	0.393	0.768	-0.052	0.716
Foreign sales only	0.376	0.001	0.013	0.067	0.099	0.180	0.556	-0.011	0.545
Foreign R&D	0.376	0.004	0.098	0.255	0.278	0.635	1.010	-0.229	0.781
No foreign activities	0.376	-0.002	-0.018	-0.054	-0.058	-0.132	0.243	0.025	0.268
Average	0.376	0.000	0.000	0.000	0.000	0.000	0.376	0.000	0.376
Low-tech firms									
Foreign production only	0.262	0.001	0.003	-0.001	0.053	0.057	0.318	0.094	0.413
Foreign sales and production	0.262	0.006	0.042	0.017	0.162	0.227	0.488	0.074	0.562
Foreign sales only	0.262	-0.004	0.012	0.011	0.127	0.147	0.408	0.092	0.500
Foreign R&D	0.262	-0.001	0.011	0.007	0.141	0.159	0.420	0.087	0.507
No foreign activities	0.262	0.000	-0.003	-0.002	-0.021	-0.026	0.235	-0.016	0.220
Average	0.262	0.000	0.000	0.000	0.000	0.000	0.262	0.000	0.262
All firms (HT+LT)									
Foreign production only	0.303	0.002	0.011	0.004	0.032	0.050	0.353	0.063	0.416
Foreign sales and production	0.303	0.008	0.072	0.085	0.167	0.332	0.635	0.012	0.647
Foreign sales only	0.303	0.004	0.025	0.048	0.125	0.202	0.505	0.022	0.528
Foreign R&D	0.303	0.007	0.074	0.108	0.241	0.430	0.733	-0.064	0.669
No foreign activities	0.303	-0.001	-0.011	-0.016	-0.036	-0.064	0.239	-0.004	0.235
Average	0.303	0.000	0.000	0.000	0.000	0.000	0.303	0.000	0.303

Table 10. Accounting for Innovation: Propensity to Innovate 2009

Foreign activities	Average firm's propensity	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected propensity	Propensity innovativity	Observed propensity
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	0.686	0.003	0.036	-0.005	-0.008	0.026	0.712	0.188	0.900
Foreign sales and production	0.686	0.003	0.096	0.005	0.062	0.167	0.853	-0.004	0.848
Foreign sales only	0.686	-0.003	0.054	0.004	0.041	0.096	0.782	0.026	0.807
Foreign R&D	0.686	-0.004	0.100	0.015	0.080	0.190	0.877	0.015	0.892
No foreign activities	0.686	0.001	-0.100	-0.004	-0.039	-0.141	0.545	0.023	0.568
Average	0.686	0.000	0.000	0.000	0.000	0.000	0.686	0.000	0.686
Low-tech firms									
Foreign production only	0.649	-0.009	0.004	-0.002	0.019	0.013	0.661	-0.030	0.632
Foreign sales and production	0.649	-0.001	0.131	0.013	0.084	0.228	0.876	-0.014	0.862
Foreign sales only	0.649	0.003	0.079	0.016	0.051	0.149	0.798	0.012	0.810
Foreign R&D	0.649	0.004	0.090	0.036	0.056	0.186	0.835	0.071	0.906
No foreign activities	0.649	0.000	-0.084	-0.007	-0.028	-0.120	0.529	0.039	0.568
Average	0.649	0.000	0.000	0.000	0.000	0.000	0.649	0.000	0.649
All firms (HT+LT)									
Foreign production only	0.667	0.024	0.012	-0.004	0.008	0.040	0.708	0.017	0.724
Foreign sales and production	0.667	0.044	0.112	0.006	0.072	0.235	0.902	-0.047	0.855
Foreign sales only	0.667	0.047	0.065	0.007	0.045	0.164	0.831	-0.024	0.808
Foreign R&D	0.667	0.045	0.095	0.017	0.069	0.226	0.894	0.005	0.899
No foreign activities	0.667	0.035	-0.049	-0.004	-0.033	-0.051	0.616	-0.048	0.568
Average	0.667	0.000	0.000	0.000	0.000	0.000	0.667	0.000	0.667

Table 11. Accounting for Innovation: New-to-the-Firm Sales 2003

Foreign activities	Average firm's sales	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected sales	Innovativity	Observed sales
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	3.329	0.021	0.093	0.087	-0.004	0.197	3.526	0.475	4.002
Foreign sales and production	3.329	0.029	0.579	0.193	0.868	1.669	4.998	2.215	7.213
Foreign sales only	3.329	0.054	0.124	0.077	0.636	0.891	4.221	1.077	5.298
Foreign R&D	3.329	0.048	0.878	0.293	1.647	2.866	6.195	2.785	8.980
No foreign activities	3.329	-0.020	-0.156	-0.062	-0.358	-0.596	2.733	-0.709	2.024
Average	3.329	0.000	0.000	0.000	0.000	0.000	3.329	0.000	3.329
Low-tech firms									
Foreign production only	2.034	0.032	0.022	-0.002	0.288	0.340	2.374	1.264	3.638
Foreign sales and production	2.034	0.017	0.258	0.058	0.737	1.070	3.103	2.674	5.777
Foreign sales only	2.034	-0.028	0.078	0.039	0.597	0.686	2.720	1.378	4.098
Foreign R&D	2.034	0.020	0.067	0.025	0.672	0.784	2.817	2.069	4.887
No foreign activities	2.034	-0.001	-0.019	-0.006	-0.101	-0.127	1.907	-0.313	1.594
Average	2.034	0.000	0.000	0.000	0.000	0.000	2.034	0.000	2.034
All firms (HT+LT)									
Foreign production only	2.508	0.023	0.085	0.006	0.203	0.318	2.826	0.902	3.728
Foreign sales and production	2.508	0.058	0.514	0.124	0.822	1.518	4.026	2.549	6.576
Foreign sales only	2.508	0.056	0.184	0.070	0.654	0.965	3.473	1.362	4.835
Foreign R&D	2.508	0.077	0.549	0.157	1.204	1.987	4.495	2.802	7.297
No foreign activities	2.508	-0.014	-0.080	-0.023	-0.186	-0.303	2.205	-0.474	1.731
Average	2.508	0.000	0.000	0.000	0.000	0.000	2.508	0.000	2.508

Table 12. Accounting for Innovation: New-to-the-Firm Sales 2009

Foreign activities	Average firm's sales	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected sales	Innovativity	Observed sales
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	2.471	-0.099	0.054	-0.027	-0.042	-0.114	2.358	0.066	2.424
Foreign sales and production	2.471	0.067	0.962	0.026	0.310	1.365	3.836	0.305	4.141
Foreign sales only	2.471	0.059	0.433	0.019	0.203	0.714	3.186	0.276	3.462
Foreign R&D	2.471	0.080	1.009	0.079	0.397	1.564	4.036	1.099	5.135
No foreign activities	2.471	0.001	-1.111	-0.020	-0.193	-1.324	1.148	0.276	1.423
Average	2.471	0.000	0.000	0.000	0.000	0.000	2.471	0.000	2.471
Low-tech firms									
Foreign production only	2.220	0.021	0.127	-0.009	0.071	0.211	2.431	0.183	2.614
Foreign sales and production	2.220	-0.038	1.048	0.073	0.392	1.475	3.695	0.708	4.404
Foreign sales only	2.220	-0.050	0.563	0.092	0.239	0.843	3.063	0.133	3.196
Foreign R&D	2.220	0.008	0.793	0.209	0.268	1.278	3.498	1.362	4.860
No foreign activities	2.220	0.014	-0.862	-0.042	-0.132	-1.021	1.199	0.289	1.488
Average	2.220	0.000	0.000	0.000	0.000	0.000	2.220	0.000	2.220
All firms (HT+LT)									
Foreign production only	2.345	0.098	0.100	-0.021	0.027	0.203	2.549	0.000	2.549
Foreign sales and production	2.345	0.130	1.011	0.031	0.344	1.516	3.862	0.402	4.264
Foreign sales only	2.345	0.130	0.484	0.035	0.215	0.864	3.209	0.160	3.370
Foreign R&D	2.345	0.160	0.908	0.088	0.330	1.485	3.831	1.177	5.007
No foreign activities	2.345	0.099	-0.414	-0.022	-0.158	-0.495	1.850	-0.391	1.459
Average	2.345	0.000	0.000	0.000	0.000	0.000	2.345	0.000	2.345

Table 13. Number of Firms by Type of Innovation Partner

(a) 2003

	Foreign production only				Foreign sales and production				Foreign sales only				Foreign R&D				No foreign activities			
	Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners	
Other enterprises within the enterprise group	13	(21%)	6	(22%)	52	(16%)	14	(21%)	69	(17%)	9	(19%)	17	(9%)	32	(23%)	218	(17%)	4	(8%)
Suppliers of equipment, materials, parts, or software	11	(18%)	8	(30%)	54	(17%)	12	(18%)	64	(16%)	6	(13%)	24	(13%)	22	(16%)	254	(20%)	12	(25%)
Clients or customers	15	(24%)	2	(7%)	53	(16%)	14	(21%)	55	(14%)	22	(47%)	20	(11%)	19	(14%)	234	(18%)	9	(19%)
Competitors and other enterprises from the same industry	4	(6%)	5	(19%)	21	(7%)	7	(10%)	43	(11%)	5	(11%)	21	(12%)	16	(11%)	155	(12%)	12	(25%)
Consultants	5	(8%)	1	(4%)	26	(8%)	2	(3%)	25	(6%)	3	(6%)	18	(10%)	12	(9%)	107	(8%)	3	(6%)
Commercial laboratories/R&D enterprises/suppliers of R&D support service	2	(3%)	1	(4%)	27	(8%)	5	(7%)	27	(7%)	0	(0%)	21	(12%)	10	(7%)	86	(7%)	3	(6%)
Universities or other higher education institutes	7	(11%)	3	(11%)	54	(17%)	11	(16%)	77	(19%)	2	(4%)	28	(15%)	23	(16%)	134	(10%)	5	(10%)
Government or private non-profit research institutes	5	(8%)	1	(4%)	36	(11%)	2	(3%)	42	(10%)	0	(0%)	32	(18%)	6	(4%)	100	(8%)	0	(0%)
Total	62	(100%)	27	(100%)	323	(100%)	67	(100%)	402	(100%)	47	(100%)	181	(100%)	140	(100%)	1288	(100%)	48	(100%)

(b) 2009

	Foreign Production only				Foreign Sales and Production				Foreign Sales only				Foreign R&D				No Foreign Experience			
	Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners		Domestic partners only		Foreign and domestic partners	
Other enterprises within the enterprise group	7	(12%)	1	(100%)	45	(12%)	31	(41%)	77	(17%)	19	(30%)	6	(5%)	23	(29%)	153	(19%)	12	(43%)
Suppliers of equipment, materials, parts, or software	11	(19%)	0	(0%)	61	(16%)	15	(20%)	87	(19%)	3	(5%)	21	(19%)	10	(13%)	159	(20%)	7	(25%)
Clients or customers	16	(28%)	0	(0%)	73	(19%)	15	(20%)	86	(18%)	25	(40%)	17	(15%)	21	(27%)	175	(22%)	6	(21%)
Competitors and other enterprises from the same industry	2	(3%)	0	(0%)	9	(2%)	3	(4%)	17	(4%)	4	(6%)	7	(6%)	6	(8%)	40	(5%)	2	(7%)
Consultants	7	(12%)	0	(0%)	43	(11%)	3	(4%)	45	(10%)	3	(5%)	12	(11%)	3	(4%)	67	(8%)	1	(4%)
Commercial laboratories/R&D enterprises/suppliers of R&D support service	7	(12%)	0	(0%)	71	(19%)	5	(7%)	80	(17%)	4	(6%)	21	(19%)	10	(13%)	109	(14%)	0	(0%)
Universities or other higher education institutes	5	(9%)	0	(0%)	50	(13%)	4	(5%)	48	(10%)	3	(5%)	19	(17%)	4	(5%)	71	(9%)	0	(0%)
Government or private non-profit research institutes	3	(5%)	0	(0%)	23	(6%)	0	(0%)	26	(6%)	2	(3%)	9	(8%)	2	(3%)	24	(3%)	0	(0%)
Total	58	(100%)	1	(100%)	375	(100%)	76	(100%)	466	(100%)	63	(100%)	112	(100%)	79	(100%)	798	(100%)	28	(100%)

Notes: Firms with only domestic partners are those who answered that the location of the corresponding partner is Japan and who do not have a partner abroad.
Firms with foreign partners are those who answered that the location of the corresponding partner is a foreign country or region, but these firms usually have a partner in Japan, too.
It should be noted that firms were asked about the location of the partner and not whether the partner is a foreign firm or a Japanese-affiliated firm.

Appendix Table 1. Estimated Marginal Effects for the Probit Model of Innovation: 2003

	High-tech industries (HT)			Low-tech industries (LT)			All mfg. industries (HT+LT)		
	dy/dx	sd		dy/dx	sd		dy/dx	sd	
Log of number of workers (1999)	0.036	0.010	***	0.021	0.006	***	0.027	0.006	***
Group membership	0.105	0.028	***	0.033	0.018	*	0.057	0.016	***
R&D/sales	0.129	0.011	***	0.026	0.004	***	0.076	0.004	***
Perceived competition	0.306	0.026	***	0.313	0.018	***	0.314	0.015	***
Proximity to basic research	0.399	0.035	***	0.439	0.032	***	0.423	0.024	***
Foreign production only	0.057	0.091		0.148	0.045	***	0.140	0.041	***
Foreign sales and production	0.204	0.053	***	0.157	0.050	***	0.191	0.037	***
Foreing sales only	0.087	0.036	**	0.148	0.036	***	0.114	0.025	***
Foreign R&D	0.151	0.078	*	0.143	0.065	**	0.152	0.051	***
Motor vehicles	0.003	0.041					-0.038	0.034	
Chemical products							-0.029	0.036	
Machinery and equipment	0.045	0.045					-0.004	0.040	
Electronics	0.074	0.036	*				0.030	0.034	
Food				-0.036	0.029		-0.040	0.033	
Textiles				-0.049	0.029		-0.058	0.033	
Wood				0.029	0.031		0.031	0.035	
Plastic products				0.048	0.034		0.046	0.038	
Non-metallic products				-0.039	0.028		-0.050	0.032	
Metal products				-0.060	0.030	*	-0.072	0.035	*
Not elsewhere classified									
Obs	2231			3862			6093		
R_2	0.3702			0.2402			0.3098		
LR chi2	1093.44	***		1066.2	***		2316.33	***	

* Significant at 10%, ** at 5%, *** at 1%.

Appendix Table 2. Estimated Marginal Effects for the Tobit Model of Innovation: 2003

	High-tech industries (HT)			Low-tech industries (LT)			All mfg. industries (HT+LT)		
	dy/dx	sd		dy/dx	sd		dy/dx	sd	
Log of number of workers (1999)	0.402	0.058	***	0.132	0.039	***	0.227	0.032	***
Group membership	0.451	0.177	**	0.139	0.111		0.249	0.094	**
R&D/sales	0.149	0.021	***	0.092	0.015	***	0.110	0.012	***
Perceived competition	2.390	0.180	***	1.899	0.106	***	2.076	0.092	***
Proximity to basic research	1.900	0.216	***	1.575	0.146	***	1.652	0.120	***
Foreign production only	0.729	0.553		0.903	0.224	***	0.939	0.222	***
Foreign sales and production	1.256	0.287	***	0.888	0.220	***	1.023	0.169	***
Foreing sales only	1.062	0.218	***	0.732	0.176	***	0.846	0.131	***
Foreign R&D	0.713	0.387	*	0.892	0.307	**	0.790	0.228	***
Motor vehicles	-0.580	0.263	**				-0.455	0.231	*
Chemical products							-0.087	0.226	
Machinery and equipment	-0.119	0.271					-0.135	0.242	
Electronics	0.138	0.218					0.080	0.204	
Food				-0.271	0.193		-0.356	0.220	
Textiles				-0.414	0.203	*	-0.505	0.232	*
Wood				0.025	0.189		-0.020	0.216	
Plastic products				0.135	0.197		0.129	0.225	
Non-metallic products				-0.465	0.192	**	-0.588	0.218	
Metal products				-0.419	0.219	*	-0.533	0.250	**
Not elsewhere classified									
Obs	2231			3862			6093		
R_2	0.1212			0.1046			0.1154		
LR chi2	869.16	***		942.51	***		1877.31	***	

* Significant at 10%, ** at 5%, *** at 1%.

Appendix Table 3. Accounting for Innovation: Propensity to Innovate 2003 (Based on the results in Appendix Table 1)

Foreign Experience	Average firm's propensity	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected propensity	Propensity innovativity	Observed propensity
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	0.376	0.007	0.021	0.076	-0.002	0.102	0.477	-0.052	0.426
Foreign sales and production	0.376	0.005	0.073	0.169	0.149	0.396	0.772	-0.056	0.716
Foreign sales only	0.376	0.002	0.013	0.067	0.100	0.183	0.558	-0.013	0.545
Foreign R&D	0.376	0.004	0.098	0.256	0.283	0.640	1.016	-0.235	0.781
No foreign activities	0.376	-0.001	-0.019	-0.054	-0.059	-0.134	0.242	0.026	0.268
Average	0.376	0.000	0.000	0.000	0.000	0.000	0.376	0.000	0.376
Low-tech firms									
Foreign production only	0.262	-0.002	0.003	-0.001	0.053	0.054	0.315	0.097	0.413
Foreign sales and production	0.262	0.005	0.039	0.016	0.165	0.225	0.487	0.075	0.562
Foreign sales only	0.262	-0.003	0.011	0.011	0.129	0.148	0.409	0.091	0.500
Foreign R&D	0.262	-0.003	0.011	0.007	0.143	0.158	0.419	0.088	0.507
No foreign activities	0.262	0.000	-0.003	-0.002	-0.022	-0.026	0.236	-0.016	0.220
Average	0.262	0.000	0.000	0.000	0.000	0.000	0.262	0.000	0.262
All firms (HT+LT)									
Foreign production only	0.303	-0.001	0.003	0.004	0.033	0.039	0.342	0.074	0.416
Foreign sales and production	0.303	0.007	0.054	0.085	0.169	0.316	0.619	0.028	0.647
Foreign sales only	0.303	0.004	0.016	0.049	0.127	0.195	0.498	0.029	0.528
Foreign R&D	0.303	0.005	0.051	0.108	0.244	0.408	0.712	-0.043	0.669
No foreign activities	0.303	-0.001	-0.008	-0.016	-0.037	-0.061	0.242	-0.007	0.235
Average	0.303	0.000	0.000	0.000	0.000	0.000	0.303	0.000	0.303

Appendix Table 4. Accounting for Innovation: New-to-the-Firm Sales 2003 (Based on the results in Appendix Table 2)

Foreign Experience	Average firm's sales	Industry effects	Size and group effects	R&D effects	Environmental effects	Sum of structural effects	Expected sales	Innovativity	Observed sales
	(1)	(2)	(3)	(4)	(5)	(6)=(2)+(3)+(4)+(5)	(7)=(1)+(6)	(8)=(9)-(7)	(9)
High-tech firms									
Foreign production only	3.329	-0.015	0.110	0.087	-0.004	0.178	3.507	0.494	4.002
Foreign sales and production	3.329	0.016	0.642	0.195	0.898	1.750	5.080	2.134	7.213
Foreign sales only	3.329	0.065	0.136	0.078	0.655	0.934	4.263	1.035	5.298
Foreign R&D	3.329	0.045	0.963	0.295	1.704	3.007	6.337	2.643	8.980
No foreign activities	3.329	-0.020	-0.172	-0.063	-0.369	-0.624	2.705	-0.681	2.024
Average	3.329	0.000	0.000	0.000	0.000	0.000	3.329	0.000	3.329
Low-tech firms									
Foreign production only	2.034	0.012	0.018	-0.002	0.295	0.322	2.356	1.282	3.638
Foreign sales and production	2.034	0.015	0.230	0.057	0.756	1.058	3.091	2.686	5.777
Foreign sales only	2.034	-0.026	0.068	0.038	0.612	0.693	2.727	1.371	4.098
Foreign R&D	2.034	0.005	0.062	0.025	0.689	0.780	2.814	2.073	4.887
No foreign activities	2.034	0.001	-0.017	-0.006	-0.104	-0.126	1.908	-0.314	1.594
Average	2.034	0.000	0.000	0.000	0.000	0.000	2.034	0.000	2.034
All firms (HT+LT)									
Foreign production only	2.508	-0.001	0.024	0.006	0.208	0.237	2.745	0.983	3.728
Foreign sales and production	2.508	0.049	0.400	0.123	0.846	1.417	3.925	2.651	6.576
Foreign sales only	2.508	0.057	0.121	0.070	0.672	0.920	3.428	1.407	4.835
Foreign R&D	2.508	0.064	0.390	0.156	1.238	1.847	4.355	2.942	7.297
No foreign activities	2.508	-0.013	-0.056	-0.023	-0.191	-0.283	2.225	-0.494	1.731
Average	2.508	0.000	0.000	0.000	0.000	0.000	2.508	0.000	2.508

Appendix Table 5. Number of Firms by Location of International Activities

(a) 2003

	Foreign production only		Foreign sales and production		Foreign sales only		Foreign R&D	
All industries								
Korea & Taiwan	42	(15%)	89	(13%)	429	(24%)	29	(11%)
China	145	(52%)	223	(32%)	318	(18%)	62	(22%)
ASEAN	56	(20%)	189	(27%)	301	(17%)	29	(11%)
US	17	(6%)	95	(14%)	345	(20%)	86	(31%)
EU	12	(4%)	62	(9%)	261	(15%)	56	(20%)
Other	7	(3%)	34	(5%)	102	(6%)	14	(5%)
Total	279	(100%)	692	(100%)	1756	(100%)	276	(100%)
High-tech industries								
Korea & Taiwan	11	(13%)	54	(13%)	286	(25%)	15	(9%)
China	30	(36%)	131	(33%)	209	(18%)	28	(16%)
ASEAN	24	(29%)	99	(25%)	203	(18%)	17	(10%)
US	9	(11%)	58	(14%)	214	(19%)	63	(36%)
EU	8	(10%)	40	(10%)	174	(15%)	42	(24%)
Other	1	(1%)	20	(5%)	68	(6%)	8	(5%)
Total	83	(100%)	402	(100%)	1154	(100%)	173	(100%)

(b) 2009

	Foreign production only		Foreign sales and production		Foreign sales only		Foreign R&D	
All industries								
Korea & Taiwan	10	(13%)	29	(9%)	222	(21%)	8	(7%)
China	50	(64%)	157	(46%)	227	(21%)	27	(25%)
ASEAN	17	(22%)	91	(27%)	164	(15%)	15	(14%)
US	0	(0%)	29	(9%)	187	(17%)	26	(24%)
EU	0	(0%)	19	(6%)	156	(15%)	20	(19%)
Other	1	(1%)	16	(5%)	118	(11%)	12	(11%)
Total	78	(100%)	341	(100%)	1074	(100%)	108	(100%)
High-tech industries								
Korea & Taiwan	6	(23%)	18	(10%)	150	(20%)	3	(5%)
China	16	(62%)	84	(48%)	152	(21%)	13	(24%)
ASEAN	3	(12%)	46	(26%)	110	(15%)	5	(9%)
US	0	(0%)	10	(6%)	131	(18%)	15	(27%)
EU	0	(0%)	9	(5%)	108	(15%)	10	(18%)
Other	1	(4%)	7	(4%)	84	(11%)	9	(16%)
Total	26	(100%)	174	(100%)	735	(100%)	55	(100%)

Notes: Some firms answered that they had activities in more than one region. Therefore, the total number is much larger than the number of firms which fall into each category for the mode of international activities shown in Table 1.

【執筆者】

羽田尚子　　中央大学商学部　准教授
　　文部科学省科学技術政策研究所　客員研究官

伊藤恵子　　専修大学経済学部　教授
　　文部科学省科学技術政策研究所　客員研究官

米谷悠　　文部科学省科学技術政策研究所　第1研究グループ研究員

DISCUSSION PAPER No.94

Modes of International Activities and the Innovativeness of Firms:
An Empirical Analysis Based on
the Japanese National Innovation Surveys for 2003 and 2009

2013 年 6 月

文部科学省　科学技術政策研究所
第 1 研究グループ

〒100-0013
東京都千代田区霞が関 3-2-2 中央合同庁舎第 7 号館 東館 16 階
TEL：03-3581-2396　FAX：03-3503-3996