รายงานวิจัยฉบับสมบูรณ์

เครือข่ายการผลิตระดับโลกและการถ่ายทอดเทคโนโลยีเพื่อยกระดับความสามารถทางเทคโนโลยีของผู้ผลิตชิ้นส่วนในอุตสาหกรรมยานยนต์ไทย

Global production network and knowledge transfer in the Thai automotive industry

โดย

เกรียงไกร เตชกานนท์

คณะเศรษฐศาสตร์ มหาวิทยาลัยธรรมศาสตร์

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บทคัดย่อ

งานวิจัยนี้วิเคราะห์วิวัฒนาการของการรวมกลุ่มผู้ผลิตในอุตสาหกรรมการผลิตรถยนต์และชิ้นส่วน โดยศึกษาถึงกระบวนการถ่ายทอดเทคโนโลยีที่เกิดขึ้นในอุตสาหกรรมผลิตรถยนต์ของประเทศไทยที่ได้กลายมาเป็นส่วนหนึ่งในเครือข่ายการผลิตระดับโลก งานวิจัยชิ้นนี้ได้อธิบายถึงบทบาทรัฐบาลและบริษัทญี่ปุ่นที่เลือกสถานที่ในการผลิต และ การยกระดับความสามารถของบริษัทลูกในประเทศไทย รายงานนี้อธิบายถึงการยกระดับความสามารถในด้านการพัฒนาผลิตภัณฑ์และการออกแบบของผู้ผลิตรถยนต์รายหนึ่ง และ ได้นำเสนอรูปแบบการถ่ายทอดเทคโนโลยีแก่ผู้ผลิตชิ้นส่วนในลักษณะเครือข่าย ซึ่งเป็นรูปแบบการจัดการแบบใหม่ ผลการศึกษาพบว่าผู้ผลิตรถยนต์ได้ลงทุนในกิจกรรมการวิจัยและพัฒนาและยกระดับความสามารถของฐานผลิตในประเทศไทยเพื่อรับการผลิตรถรุ่นใหม่ให้สูงขึ้น นอกจากการนำเสนอผลการวิจัยในระดับกิจการแล้ว งานวิจัยนี้ได้ศึกษาเพิ่มเติมเกี่ยวกับความร่วมมือกันในการทำวิจัยและพัฒนาระหว่างผู้ผลิตกับภาคส่วนต่างๆ เช่น ลูกค้า ผู้ขายวัตถุดิบ สถานศึกษา และ หน่วยงานรัฐ ผลการศึกษาพบว่าผู้ผลิตไทยยังมีข้อจำกัดในระดับพื้นฐานวิทยาศาสตร์และเทคโนโลยี ซึ่งจะเป็นอุปสรรคในการยกระดับกิจการในห่วงโซ่อุปทานระดับโลกที่มีบริษัทต่างชาติเป็นผู้นำ ในภาวะการแข่งขันและการเปิดเสรีทางการค้า รัฐบาลไม่สามารถออกนโยบายปกป้องอุตสาหกรรมให้เช่นที่เคยทำในอดีต ดังนั้นจึงควรปรับบทบาทมาสนับสนุน สร้างสาธารณูปโภคพื้นฐานทางวิทยาศาสตร์และเทคโนโลยีเพื่อให้ผู้ประกอบการสามารถเข้าถึงและนำไปสู่การสร้างนวัตกรรมใหม่ที่เป็นความรู้ของคนไทยได้ต่อไป

Abstract

This research analyses the evolution of clusters and the process of technology transfer in product development and design capabilities in automotive sector (firm level) and cooperation in R&D activities of firms in manufacturing sector (industry level). The upgrading process was analysed in line with key concepts constituting ‘interactive learning’, which include clusters and agglomeration, (regional) innovation systems, open innovation, and localised learning. Based on firm-level and industry-wide levels, this paper contributes to current literature concerning clusters and innovation that relate to technological upgrading in locally-based firms by a) examining the role of

governments in promoting clusters and regional development; b) identifying the conditions important for firm agglomeration; and how agglomeration leads to knowledge-sharing at horizontal, vertical and institutional levels; c) discussing the role of foreign firms in transferring technology to their affiliate and encouraging their suppliers to share knowledge within the production network; and d) reporting on the characteristics and determinants of R&D cooperation within the Thai manufacturing sector. The main findings reveal that developing countries, including Thailand at this moment, may have limitations in their science and technology base. This can hinder their upward progression on the global value chain. It is of particular importance for government policy to be more supportive, rather than regulative, in order to strengthen the scientific knowledge base and promote cooperation between indigenous firms and innovation in supporting organisations.

Keywords: global production network, automobile industry, agglomeration economies, knowledge transfer, knowledge sharing, open innovation

Executive Summary

บทสรุปผู้บริหาร

ปัญหาที่ทำการวิจัย และความสำคัญของปัญหา

อุตสาหกรรมการประกอบรถยนต์เป็นอุตสาหกรรมที่มีบทบาทสำคัญต่อภาคเศรษฐกิจของไทยทั้งในแง่การจ้างงาน การผลิต การส่งออก รวมถึงการพัฒนาอุตสาหกรรมสนับสนุน ผลจากการส่งเสริมอุตสาหกรรมด้วยนโยบายที่มีความชัดเจนเพื่อกระตุ้นให้เกิดการพัฒนาอุตสาหกรรมในภาพรวม ส่งผลให้อุตสาหกรรมการผลิตรถยนต์และอุตสาหกรรมการผลิตชิ้นส่วนเติบโตอย่างรวดเร็ว ปริมาณการผลิตรถยนต์และปริมาณการส่งออกที่เพิ่มขึ้นอย่างต่อเนื่องในช่วงทศวรรษที่ผ่านมาเป็นหลักฐานที่เป็นรูปธรรมของความสำเร็จของการพัฒนานี้ นอกจากนี้ ความสามารถของผู้ผลิตชิ้นส่วนในประเทศก็พัฒนาขึ้น โดยสะท้อนจากความเที่ยงตรงและคุณภาพของชิ้นส่วนที่ผลิตได้ในประเทศสูงขึ้น หลักฐานเชิงประจักษ์เหล่านี้ทำให้สรุปได้ว่าประเทศไทยโดยรวมมีการพัฒนาระดับเทคโนโลยีการผลิตอย่างมากในช่วงห้าทศวรรษของการพัฒนาอุตสาหกรรม

แม้ว่าประเทศไทยจะกลายมาเป็นประเทศส่งออกรถยนต์รายใหญ่รายหนึ่งของภูมิภาคเอเชีย และ เป็นศูนย์กลางการผลิตและส่งออกในฐานะหนึ่งในเครือข่ายการผลิตรถยนต์ที่สำคัญของค่ายรถต่างๆ นักวิชาการและผู้กำหนดนโยบายยังคงมีความสงสัยอยู่ว่าที่ผ่านมานั้นมีการถ่ายทอดเทคโนโลยีสู่ประเทศไทยจริงจังเพียงใด ซึ่งนักวิชาการจำนวนไม่น้อยมีความคลางแคลงว่าบริษัทต่างชาติต่างๆ ไม่ได้ทำการถ่ายทอดเทคโนโลยีอย่างจริงจังเพราะจวบจนปัจจุบันนี้คนไทยก็ยังไม่สามารถผลิตรถยนต์ได้ด้วยตัวเอง และเห็นว่าประเทศไทยไม่ได้ประโยชน์อะไรมากไปกว่าการเป็นประเทศที่ให้บริการด้านแรงงานเพื่อกิจการประกอบรถยนต์แก่ต่างชาติเท่านั้น อย่างไรก็ดี การกล่าวเช่นนี้ก็ดูจะไม่เป็นธรรมนัก เพราะในความเป็นจริงแล้วประเทศไทยได้มีการพัฒนาความสามารถในการผลิตเพิ่มขึ้น ไม่ว่าจะเป็นคุณภาพสินค้าที่ดีขึ้น (รถยนต์ที่ส่งออก

จำเป็นต้องมีผ่านมาตรฐานความปลอดภัยของผู้นำเข้า) จำนวนรุ่นที่มากขึ้น ปริมาณการผลิตที่สูงขึ้น ซึ่งสิ่งเหล่านี้ไม่มีทางเกิดขึ้นหากฐานผลิตในประเทศไทยไม่มีศักยภาพทางวิศวกรรมและการจัดการการผลิตที่ดีพอ แต่เนื่องจากเรามีงานวิจัยในประเด็นนี้น้อย จึงทำให้ภาพที่เป็นรูปธรรมของการถ่ายทอดเทคโนโลยีในอุตสาหกรรมนี้ยังไม่ชัดเจน

อย่างไรก็ดี อุตสาหกรรมการผลิตรถยนต์ของไทยได้มีการเปลี่ยนแปลงอย่างมากในช่วงสี่ห้าปีมานี้ ดังที่เราทราบดีว่าอุตสาหกรรมนี้ได้รับผลกระทบอย่างมากจากวิกฤตเศรษฐกิจเมื่อปี 2540 ที่ทำให้บริษัทต่างๆ ต้องทำการปรับตัวเพื่ออยู่รอด ประกอบกับการยกเลิกการบังคับใช้ชิ้นส่วนในประเทศในปี 2543 แต่การเปลี่ยนแปลงที่สำคัญที่ถือได้ว่าเป็นจุดหักเหของอุตสาหกรรมยานยนต์ของไทยคือการที่บริษัทต่างๆ ที่ลงทุนในประเทศไทยทั้งรายเก่าและรายใหม่ได้ตัดสินใจใช้ประเทศไทยเป็นฐานการผลิตและส่งออกในภูมิภาคเอเชีย ซึ่งเหตุผลส่วนหนึ่งของปรับเปลี่ยนกลยุทธ์การผลิตนี้มาจากการการเปลี่ยนแปลงเชิงโครงสร้างอุตสาหกรรมของโลก (Terdudomtham et al 2002) ด้วยเหตุนี้เองจะทำให้อุตสาหกรรมรถยนต์ของไทยจะพัฒนาไปเป็นส่วนหนึ่งในโครงข่ายการผลิตระดับโลก (Global Production Network; GPN) ของผู้ผลิตหลายค่าย ซึ่งจะส่งผลให้ประเทศไทยกลายมาเป็นฐานการผลิตรถยนต์ (โดยเฉพาะอย่างยิ่งรถกระบะ) ที่ใหญ่ที่สุดในโลก นอกจากนี้ จากการส่งเสริมการลงทุนในโครงการอีโคคาร์ ก็มีบริษัทหลายรายสนใจและบางส่วนได้เริ่มการผลิตแล้ว เช่น บริษัทนิสสัน สามารถส่งออกรถยนต์ Nissan March ที่ประกอบในประเทศไทยได้รับการตอบรับที่ดีจากลูกค้าในประเทศ และ สามารถส่ออกกลับไปขายในตลาดญี่ปุ่นอีกด้วย ดังนั้นจึงอาจกล่าวได้ว่าปัจจุบันนี้ถือเป็นจุดเปลี่ยนแปลงที่สำคัญอีกครั้งของอุตสาหกรรมยานยนต์ไทย เพราะบริษัทต่างชาติหลายรายจะทำการถ่ายทอดเทคโนโลยีในระดับที่สูงขึ้นกว่าที่เคยถ่ายทอดมา คือเป็นเทคโนโลยีการพัฒนาผลิตภัณฑ์ใหม่ เทคโนโลยีวิศวกรรมผลิตภัณฑ์ (Product engineering technology) เทคโนโลยีการออกแบบ (Design technology) และ แม้กระทั่งกิจกรรมการวิจัยและพัฒนา (Research and Development activity)

งานวิจัยชิ้นนี้วัตถุประสงค์ดังต่อไปนี้

1. เพื่อศึกษากระบวนการถ่ายทอดเทคโนโลยีในระดับวิศวกรรมผลิตภัณฑ์และการวิจัยและพัฒนาที่บริษัทรถยนต์ต่างชาติถ่ายทอดแก่บริษัทลูกในประเทศไทยและความร่วมมือและความมีส่วนร่วมของผู้ผลิตชิ้นในการพัฒนาผลิตภัณฑ์ใหม่อย่างไร

2. เพื่อศึกษาและวิเคราะห์ความสัมพันธ์ของผู้ผลิตรถยนต์กับผู้ผลิตชิ้นส่วนในเครือข่ายโดยเน้นประเด็นการพัฒนาและถ่ายทอดเทคโนโลยีแก่ผู้ผลิตชิ้นส่วน

3. เพื่อวิเคราะห์บทบาทความร่วมมือในกิจกรรมการวิจัยและพัฒนาในภาคอุตสาหกรรม

ระเบียบวิธีวิจัย

การวิจัยชิ้นนี้เน้นการวิจัยภาคสนามเป็นสำคัญ เนื่องจากข้อมูลที่จำเป็นต่อการวิเคราะห์นั้นเป็นข้อมูลใหม่ซึ่งไม่ปรากฏในรูปของเอกสารชั้นสอง การนำเสนอผลการวิจัยจะเป็นเชิงพรรณนา และ จัดเป็นงานวิจัยเชิงคุณภาพ ผู้วิจัยได้ขอความอนุเคราะห์จากบริษัทรถยนต์ที่มีแผนการผลิตที่ใช้ประเทศไทยเป็นศูนย์กลางการผลิต เพื่อขอสัมภาษณ์เชิงลึกกับบุคคลที่เกี่ยวข้องในกระบวนการถ่ายทอดเทคโนโลยีทั้งชาวไทยและชาวต่างประเทศ โดยผู้วิจัยได้อาศัยข้อมูลที่เผยได้รับจากบริษัทโตโยต้าและจากเอกสารวิชาการ หนังสือที่อธิบายถึงโครงการการผลิตรถยนต์ในเมืองไทย ดังนั้นกรณีโตโยต้าจึงมีความเหมาะสมเพราะถือได้ว่าเป็นบริษัทที่มีโครงการใช้ไทยเป็นศูนย์กลางการผลิตในฐานะเครือข่ายการผลิตอย่างชัดเจนที่สุด นอกจากนี้ ผู้วิจัยได้อาศัยข้อมูลจากการสำรวจของสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ (Innovation Survey in 2001) เพื่อวิเคราะห์ถึงปัจจัยที่กำหนดความร่วมมือในการทำวิจัยและพัฒนาของภาคการผลิตของไทยกับภาคส่วนต่างๆ อีกด้วย

การนำเสนองานวิจัย

รายงานวิจัยนี้มีทั้งสิ้น 5 ส่วน โดยในส่วนแรกเป็นบทนำที่นำเสนอความสำคัญของปัญหา วัตถุประสงค์ของการศึกษา ส่วนที่สองเป็นแนวคิดของการศึกษาโดยผู้เขียนได้อธิบายถึงแนวคิดที่เชื่อมโยงประเด็นเรื่องการพัฒนาเครือข่ายหรือการรวมกลุ่มของผู้ผลิตในลักษณะคลัสเตอร์ ซึ่งจะ

ทำให้เกิดประโยชน์จากการรวมกลุ่ม เช่น การลดต้นทุนธุรกรรมในการติดต่อกับลูกค้า ลดต้นทุนค่าขนส่ง หรือได้ประโยชน์จากการช่วยเหลือทางเทคนิค เป็นต้น การเรียนรู้ที่เกิดขึ้นในกลุ่มอุตสาหกรรมนี้จะเอื้อให้เกิดการพัฒนาทางเทคโนโลยีได้ ซึ่งเมื่อมองจากงานในแขนงการถ่ายทอดเทคโนโลยีแล้ว เรื่องนี้มีความคล้ายคลึงกัน ดังนั้นการทบทวนในส่วนนี้จะเป็นการชี้ให้เห็นช่องทางหรือโอกาสที่ประเทศผู้รับการลงทุนจะได้ประโยชน์จากการพัฒนาอุตสาหกรรม

ส่วนที่สามนำเสนอประวัติการพัฒนาของอุตสาหกรรมยานยนต์ โดยอธิบายถึงบทบาทของนโยบายพัฒนาอุตสาหกรรมของรัฐบาลไทยว่ามีส่วนช่วยให้เกิดการขยายตัวของอุตสาหกรรมได้อย่างไร นโยบายที่มีความสำคัญคือการบังคับใช้ชิ้นส่วนในประเทศในอัตราที่กำหนด แต่ในขณะเดียวกัน นโยบายที่มีความสำคัญไม่ยิ่งหย่อนกว่ากันคือนโยบายการพัฒนาอุตสาหกรรมไปสู่ภูมิภาค ซึ่งรวมถึงการส่งเสริมการลงทุนโดยการให้สิทธิประโยชน์ และ การลงทุนสร้างเครือข่ายคมนาคมทั้งระบบถนนและราง รวมถึงการสร้างท่าเรือน้ำลึกที่แหลมฉบังและมาบตาพุด ซึ่งทำให้ผู้ผลิตในหลายอุตสาหกรรมไปตั้งโรงงานในภาคตะวันออกของไทย หนึ่งในอุตสาหกรรมที่ได้อานิสงส์ด้วยคืออุตสาหกรรมการผลิตรถยนต์และชิ้นส่วน ผลของการพัฒนานี้ทำให้อุตสาหกรรมการผลิตรถยนต์ของไทยก้าวสู่การเป็นฐานการผลิตเพื่อส่งออกอย่างเต็มตัวในปัจจุบัน

ส่วนที่สี่ นำเสนอผลการศึกษาเกี่ยวกับการถ่ายทอดเทคโนโลยีในระดับการพัฒนาผลิตภัณฑ์และการออกแบบ โดยอาศัยกรณีของโตโยต้าเป็นกรณีศึกษา ผลการศึกษาชี้ว่าโตโยต้าได้เริ่มส่งเสริมให้วิศวกรไทยได้เรียนรู้กิจกรรมการวิจัยและพัฒนาโดยการส่งคนไปอบรม ทำงานในศูนย์วิจัยที่ประเทศญี่ปุ่น การเรียนรู้ของบุคลากรไทยอาศัยการเรียนรู้จากการทำงานเป็นหลัก แต่ประเด็นสำคัญที่ช่วยให้การเรียนรู้สำเร็จได้นั้นคือ ทางโตโยต้าเน้นให้มีการ “ถอดรหัส” ความรู้ที่ได้เรียนรู้ออกมาโดยการเขียนคู่มือ หรือ รายงานเพื่อให้หัวหน้าได้ตรวจสอบ การจัดการความรู้ในองค์กรของโตโยต้ามีความน่าสนใจเพราะได้อาศัยระบบสารสนเทศและอินเตอร์เน็ตในการเก็บความรู้ในระบบคอมพิวเตอร์ซึ่งเชื่อมโยงกับฐานการผลิตอื่นๆ ทั่วโลก ดังนั้นแนวการทำงานที่ดีที่สุด (Best practice) ในด้านต่างๆ เช่น การพัฒนาผลิตภัณฑ์ การออกแบบ หรือ วิธีการผลิต จะ

สามารถแบ่งปันผ่านระบบเครือข่ายภายในของบริษัทได้ และ เมื่อมีการปรับปรุงใหม่ ความรู้ใหม่ก็จะถูกปรับเข้าไปแทนที่ ดังนั้นทุกฐานการผลิตก็สามารถเข้าถึงวิธีการที่ดีที่สุดได้ การวิจัยนี้ค้นพบว่าประเทศไทยเป็นประเทศที่โตโยต้าได้ลงทุนในกิจกรรมการวิจัยและพัฒนา มีการออกแบบและพัฒนาชิ้นส่วนสำหรับรถที่ผลิตในประเทศบ้างบางรายการ แม้ว่าการออกแบบ พัฒนา และทดสอบยังคงทำในประเทศญี่ปุ่นก็ตาม แต่ในขณะที่ประเทศไทยก็ได้ก้าวเข้าไปในขั้นตอนนี้มากขึ้น อย่างไรก็ดี รายละเอียดในเรื่องนี้ยังเป็นสิ่งที่จำเป็นต้องมีการวิจัยในรายละเอียดเพิ่มเติมต่อไป

นอกจากการถ่ายทอดความรู้สู่ฐานการผลิตในไทยแล้ว โตโยต้ายังมีการถ่ายทอดความรู้ให้กับผู้ผลิตชิ้นส่วนอีกด้วย วิธีการถ่ายทอดที่ใช้นี้มีลักษณะพิเศษคือใช้การถ่ายทอดระหว่างผู้ผลิตชิ้นส่วนในเครือข่ายด้วยกัน โดยโตโยต้าเป็นผู้ที่ประสาน และ ให้ความช่วยเหลือบางด้านแก่ผู้ผลิตชิ้นส่วนที่ต้องการพัฒนาศักยภาพ โดยเฉพาะอย่างยิ่งคือการถ่ายทอด “วิถีแห่งโตโยต้า” หรือ Toyota Production System เพื่อให้สามารถตอบสนองต่อความต้องการที่สูงขึ้นของโตโยต้าได้ ในตอนท้ายของส่วนที่สี่นำเสนอปัจจัยที่มีผลต่อความร่วมมือในการทำกิจกรรมวิจัยและพัฒนาของผู้ประกอบการในประเทศไทย ผลการศึกษาชี้ว่า บริษัทไทยยังมีข้อจำกัดในการเข้าถึงเทคโนโลยีใหม่ๆ มีความเชื่อมโยงกับภาคส่วนต่างๆ ไม่มากนัก ต่างจากบริษัทที่มีทุนต่างชาติจะสามารถเข้าถึงเทคโนโลยีการผลิตใหม่ๆ ได้มากกว่า

ส่วนสุดท้ายคือบทสรุป ซึ่งข้อค้นพบของการศึกษานี้ได้สะท้อนให้เห็นว่าภาครัฐจำเป็นต้องให้ความสำคัญในเรื่องการพัฒนาโครงสร้างพื้นฐานทางวิทยาศาสตร์และเทคโนโลยี เพื่อให้ผู้ประกอบการไทยสามารถใช้ประโยชน์ อันจะนำไปสู่การสร้างความรู้ที่เป็นของคนไทย และ จะช่วยให้คนไทยสามารถยกระดับตนเองในห่วงโซ่อุปทานการผลิตระดับโลกของผู้ผลิตต่างชาติได้ การกำหนดนโยบายที่เหมาะสมเพื่อให้ผู้ประกอบการไทยพร้อมที่จะก้าวสู่พรมแดนความรู้ใหม่ๆ จะมีส่วนสนับสนุนการพัฒนาอุตสาหกรรมให้มีความยั่งยืนได้

Global production network and knowledge transfer in the Thai automotive industry

1. Introduction

Technological innovation in manufacturing companies is one of the main factors driving industrial competitiveness and national development (Freeman, 1982; Porter, 1985). However, technological development is not an automatic process (Hobday and Rush 2007) and requires purposeful resource allocation. Although the majority of the previous literature analyzes the influence of innovation in industrialized developed countries, there have been an increasing number of empirical studies examining technological capability building in technology-follower countries[1] (e.g., Lall 1987, Hobday 1995, Kim 1997, Forbes and Wield, 2000). One conclusion drawn from these studies is that the innovative task in technology-follower firms and countries is different from those in developed ones. It depends upon various socio-economic dimensions and the prevailing cultural context, encompassing such factors as competition and market structure; the national institutional structure and various networks. Therefore, a challenging question for latecomers is how to promote and upgrade their technological capabilities and competitiveness.

Historically, the technological development of latecomers tends to follow the pattern of product life cycle outlined in Vernon (1966), in which they enter onto the

[1] Technology-followers mean firms from newly industrializing countries who do not define the state-of-the-art in technology.

technology ladder from a standardized or mature industry. Foreign firms, or MNEs, relocated their standard product to low cost countries, presenting the opportunity for local firms to learn and upgrade. The vast literature on the positive effects of FDI has confirmed that it can be a means to promote economic development, through demonstration, competition, the spillover effect, and technology transfer (Dunning 1983, Borensztein et al 1995, Blomström and Kokko 1998, Markusen and Venables 1999, Moran et al. 2005).

With developing countries, conditions are different from developed ones in several aspects, at least with respect to intrinsic disadvantages, such as the lack of well-developed infrastructure, insufficient savings, capital and technology, limited manufacturing experience, geographical distribution, and their position in the global value chain (Poapongsakorn and Techakanont 2008, Chaminade and Vang 2008a). Economic development is not automatic and some intervention is necessary to correct, remedy and support industrial collaboration in directing scarce resources to improve dynamic competitive advantage (Shafaeddin 2008). Governments can promote industries and regions by the provision of direct and indirect incentives, such as infrastructure improvements and investment incentives, to individual firms to locate in such regions. Many empirical studies found that during the early stage government can play an active role in promoting the industry and setting the ground for manufacturing activities. As industries grow, firms agglomerate in a specific region and agglomeration economies become realized (e.g., Yusuf et al. 2008, Chaminade and Vang 2008b).

Thus, at the initial stage, they have to rely on external sources of technology and investment. Government policies can be an important tool in formulating such development. MNEs, through FDI, can facilitate industrialization and stimulate the transformation of clusters towards a higher value-added position in the value chain

because they bring capital and technology into the host economies (Hoekman and Javorcik 2006). International players can play an important role in shaping the scope of interactive learning and the growth of local firms (Guiliani et al. 2005). Interaction among businesses within geographic boundaries or regions, therefore, should be viewed as systems of knowledge accumulation, rather than just production systems, and public policy should respond by shifting focus to nurturing the conversion of production clusters towards innovation systems (Bassant 2008).

Although there has been an increasing amount of research analyzing the role of clusters and innovation, less attention has been paid to the evolution of clusters, interactive learning and innovation in developing countries. The experience of developing countries is different from developed ones, thus, the connotation of clusters and innovation should be conceptualized as a part of global value chains or production networks. As Yusuf et al. (2008) found in a review of several clusters in Asia, cluster development depends on several factors, such as the comparative advantages of each nation (or region), the level of local investment, the strategies of firms, the emergence of new firms, and the readiness of infrastructure. In addition, industrial clusters should be viewed in a regional or broader context wherein human and social capital is essential as grounds for technological capability upgrading. Such dynamic capability upgrading depends on the public policy towards economic and industrial development, which certainly requires intervention by government in policy formulation and implementation. The effects of such interventions may take several decades to be realized. Policy framework should be designed to direct scare resources to expand production capacity and upgrade the industrial sector.

Therefore, this paper attempts to contribute to the literature in this field by outlining the experience of Thailand's cluster development. Such an evolution takes

several decades to transform the basic operations under an import-substitution regime to become an export-oriented and export base for some key industries. Thailand is a suitable case for this purpose because of three reasons. Firstly, Thailand is a developing country with a relatively short experience of industrialization (less than 50 years) and has virtually no manufacturing background. However, it has become a part of global production networks concerning some key products, such as automobiles and electronic devices and components.[2] Second, the government policy regime has gradually shifted from being strictly protected and inward-looking towards adopting more liberalized trade and investment schemes. Thailand had previously greatly relied on FDI as a locomotive to upgrade local supporting industries. Thirdly, 'interactive learning' emerged from the agglomeration of firms in production networks and other institutions, such as universities and research institutes, in the economy. A recent innovation survey undertaken by the National Science and Technology Development Agency (NSTDA) revealed that there exists research and development cooperation between industrial firms and other bodies. Hence, this research should provide some policy implications for promoting clusters and innovation in other developing economies.

The organization of this paper is as follows; after the introduction, Part 2 reviews conceptual frameworks related to clusters and upgrading. Special attention will be placed on 'interactive learning' and 'innovation'. Part 3 discusses the historical development of the automotive cluster in Thailand. This section addresses the question differently from existing literature by focusing on the influence of government policies

[2] Based on data from the Ministry of Commerce, the export value of electronics industry, i.e., office automation, data processing devices, hard disk drives, integrated circuits, and the automotive sector (vehicles and parts) in 2007 was more than 38 billion US dollars.

on the production and location strategies of assemblers (especially, Japanese firms), which explains the agglomeration of firms in some areas. The main issue is the reasons for the emergence of clusters in the Eastern Seaboard area. In Part 4, characteristics of knowledge sharing and benefits of production networks in Thailand will be presented. Based on the work of Charoenporn (2006) and NSTDA innovation survey, we will discuss how local firms in general utilize external sources of knowledge as a means to innovate or to have cooperation in research and development activities with other entities in the economy. Part 5 offers some conclusions and policy implications.

2. Clusters, Interactive Learning and Innovation

Regional development and clustering of industrial activities in developing countries has received attention from researchers as a means to promote, support, and upgrade local firms (Giuliani et al. 2005, Chaminade and Vang 2008b, Van de Vrande et al. 2008, Poapongsakorn and Techakanont 2008, Yusuf et al. 2008). The benefits of clusters to host economies include employment generation by the collocation of firms, knowledge spillover generated by a high degree of networking among firms in the region or cluster, and innovative activity that helps upgrade local firms to new arenas of business (Yusuf 2008: 2-3), such as to link local cluster with the global production network of multinational enterprises (MNEs) (Bassant 2008). The collocation of firms and innovation supporting organizations can promote the 'interactive learning' process, which in turn provides an opportunity for local firms to upgrade their capabilities (Asheim and Coenen 2005, Malmberg and Maskell 2006, Chaminade and Vang 2008a). Upgrading refers to innovative activity that leads to an incremental improvement in existing products – quality or productivity improvement, moving to higher value-added or more skilled activities – or to create new products, which is crucial to enhance the competitiveness of the host economy (Porter 1990).

Based on this premise, FDI can be an important player in transmitting knowledge to host economies and promoting 'localized knowledge spillover' (Breschi and Malerba 2007) or 'localized learning' (Malmberg and Maskell 2006). The governments of host economies aim to promote industrial activity by creating dynamic technological upgrades. The spatial proximity among players is an important factor in determining the effectiveness and cost of technology transfer, as Breschi and Malerba (2007: p. 2) assert, "knowledge can only be effectively transmitted through interpersonal contacts and interfirm mobility of workers, both of which are eased by close geographical and cultural proximity". In this line of thinking, clusters and innovation systems are key factors in promoting technological development. Recent studies on systems of innovation suggest that collocation of firms and innovation supporting organization in a region can yield positive externality of agglomeration (Guerrire and Pietrobelli 2006, Chaminade and Vang 2008b, Cainelli 2008). However, innovation and technological upgrading depends on the absorptive capacity and research and development (R&D) capability of local firms, as it enables them to learn from knowledge created by other entities (Cohen and Levinthal 1989). This calls for the role of central government in providing 'soft' infrastructure, such as education and/or scientific and technology institutions, which are a crucial source of knowledge allowing for indigenous firms to innovate. A clear example is the Bangalore software cluster (Basant 2008, Chaminade and Vang 2008b).

According to Asheim and Coenen (2005), there are two main types of players in the cluster. The first group is firms in industrial clusters, i.e., suppliers, producers, and customers. The second group is supporting or backing up the innovative activity of the first group, i.e., universities, technical institutes, business associations, finance institutions. From the system of innovation perspective, supporting SMEs in the process

of technological upgrading is a matter of supporting interactive learning (Lundvall 1992). Therefore, we can argue that 'interactive learning' constitutes a main part of the success of upgrading of firms in the cluster. Interactive learning is defined as the process of knowledge acquisition through extensive collaboration with other players in the system. It will take place when both human and social capital are present (Chaminade and Vang 2008b).

The importance of 'interactive learning' between local firms and other economic entities and institutions has been emphasized in literature on 'innovation systems', 'open innovation' and 'regional innovation systems' (e.g., Chesbrough 2003, Fritsch and Franke 2004, Chaminade and Vang 2008b, Von Hippel 1988, Lundvall 1992). For firms in developing countries, it is difficult to undertake development or create technology solely on their own. Instead, it is more likely that a substantial proportion of new knowledge or innovative ideas emerge from interaction among firms in different stages along value chains. Three types of linkage can be identified; 1) vertical linkage with suppliers and/or customers, 2) horizontal linkage with competitors or firms in the same industry, and 3) institutional linkage with other public/private universities or technology institutions (Laursen and Salter 2006, Asheim and Coenen 2005, Malmberg and Maskell 2006). This is known as 'open innovation', in which firms improve their innovative performance through collaboration with buyers, suppliers, universities, or research institutes (Chesbrough 2003, Van de Vrande et al. 2008). This seems to be a persuasive mode for firms in developing countries to access, explore, and exploit technology because of the inherit disadvantages of fully relying on their own research and development. Consequently, interaction with other sectors is a more plausible strategy and this paper attempts to fill this gap by examining the 'interactive learning' in the Thai industrial sector as a case study.

The effectiveness of localized learning is dependent on the absorptive capacity (human capital) of local firms (Cohen and Levinthal 1989) and norms that shape the interaction among businesses and other institutions in the economy (social capital) (World bank 2002). For latecomers, it is quite difficult to create new technology or make radical innovation. Consequently, as suggested by Korean experience (Kim 1997), local firms should pursue different strategies in their R&D activities, i.e., to make incremental improvements in their products or processes. In this respect, local firms can acquire knowledge from several sources in three dimensions, vertical (from suppliers & customers), horizontal (from competitors or firms in the same industry/business) and institutional (from universities or public/private institutes) (Von Hippel 1988, Chesbrough 2006, Van de Vrande et al. 2008). This interaction is similar to 'technology exploration' in the framework of 'open innovation' literature.

In this paper, the term "cluster" is used to refer to the agglomeration of firms in related industries geographically bounded in regional systems. In this regard, clusters and systems of innovation share similar views on 'localized learning' among firms and other players in the region or economy. As Breschi and Malerba (2007) argue, local firms can learn new technology through several forms of relationship, such as user-producer relationships, formal and informal cooperation, and mobility of skilled workers from existing firms, universities, or technology institutes. Hence, there are multiple ways for local firms to tap into the knowledge and capabilities circulating locally, but this depends upon the ability to establish and maintain linkages with other players. Recent developments and advances in information and communication technology (ICT) have eroded and redefined the importance of distance in management operations across countries and knowledge transfer (Guerrieri and Pietrobelli 2006). In this new era, technology has become more codified and easier to transfer or share via

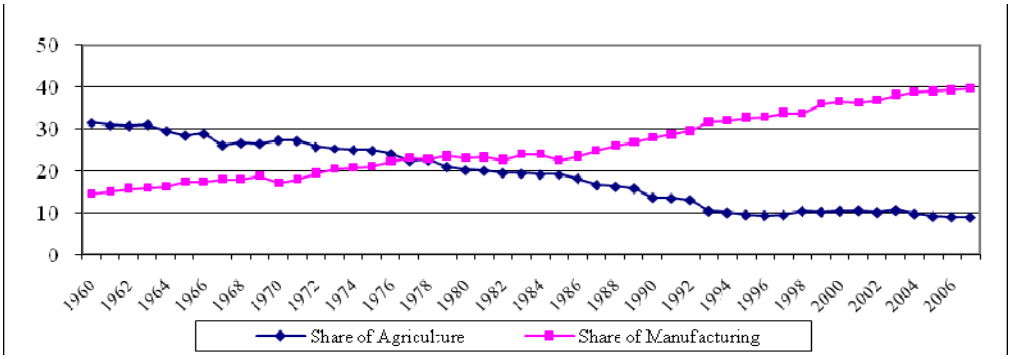
globalization. This may change the way firms operate, share and create knowledge, and maintain inter-firm relationships with distant suppliers or customers, and affect the localized learning of firms. To understand this, we will analyze the emergence and evolution of automotive clusters in Thailand. Special attention is paid to interactive learning and how local firms benefit from participation within this network.

3. Evolution of Automotive Clusters in Thailand

Since the early stages of industrialization in the 1960s, the structure of the Thai economy has changed dramatically. The share of the manufacturing sector as a component of GDP continually increased and overtook that of the agricultural sector in 1977, increasing from around 15 percent in 1961, to 26.7 and 36 percent in the 1980s and 1990s, respectively. In 2007, the share of manufacturing was 39.6, see Figure 1.A. Similar to output share, Thai exports have shifted from predominantly agricultural towards more manufacturing-related products since the latter half of the 1970s. Manufacturing exports grew rapidly in the 1980s, and their share reached 80 percent in 1993. Subsequently, in 2007 the figure accounted for 88.3 percent, see Figure 1.B. Thailand has experienced remarkable economic growth and industrialization in the past three decades, with an average growth rate of real GDP during 1961-1996 of higher than seven percent. In 1997-1998, economic growth was interrupted by the financial crisis, however, the economy was resilient and rebounded quickly, attaining a growth rate of between five and ten percent during 2003 and 2007. Based on export data from the Ministry of Commerce, Thailand's main exports are manufacturing products, including electrical and electronics goods, vehicles and parts, machinery, chemicals, iron and steel. Together they accounted for more than 60 billion USD in 2007.

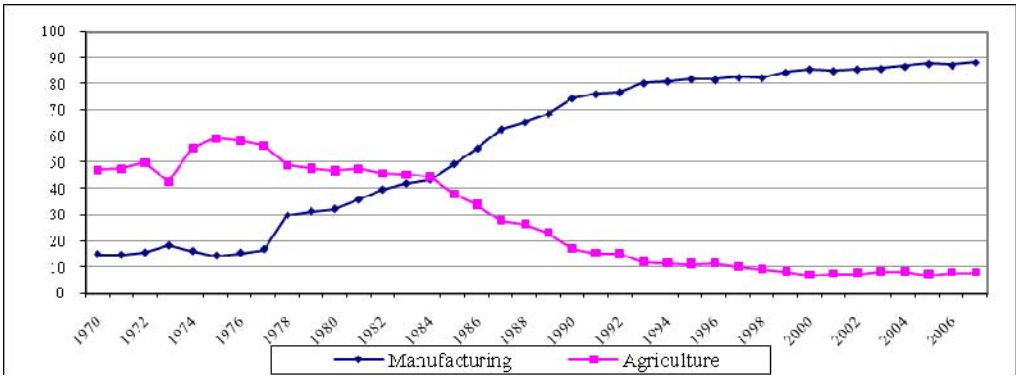
Figure 1 Thai Structural Change (1950-2007)

Figure 1.A GDP Share (percent)



Source: NESDB

Figure 1.B Export Share (1970-2007)



Source: Bank of Thailand

As outlined above, the economic and industrial structure of Thailand has developed drastically in the past two decades. This is attributable to FDI from Japan and other countries and regional and global integration through trade. However, the role of MNEs that helped improve Thailand's dynamic comparative advantage was shaped by a series of streamlining government policies. These included national

economic development plans, specific sets of policies directed towards specific manufacturing sectors (Techakanont and Terdudomtham 2004a), political and macroeconomic stability (Poapongsakorn and Techakanont 2008), infrastructure development (i.e., industrial estates, road networks, seaports) (Watanabe 2003), and trade liberalization that spurred the process of regional integration (Kohpaiboon 2005, Nidhiprabha 2007). These studies documented the chronological development of Thailand's economic and industrial policies. Thus, this section will focus on some specific aspects of government policies underlying the success of industrialization and the development of clusters and pathways towards integration into the GPN of the automobile industry.

3.1 Brief View of Thai Industrialization and Regional Development Policies

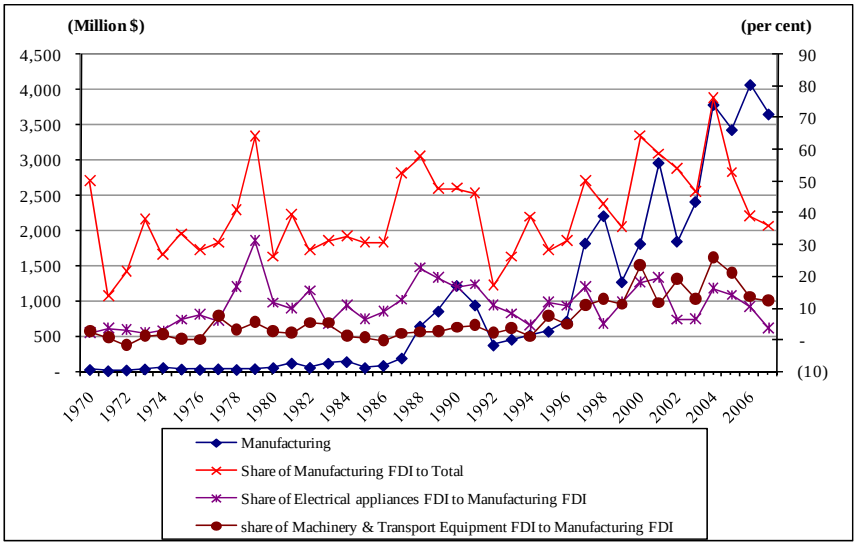
Thailand's industrialization dates back to the 1960s when the Thai government promoted import-substitution (IS) policies (1960-1970s), by providing investment incentives, granted by the BOI, and protecting the domestic market. With a private-led strategy, this policy was able to entice FDI to set up their assembly plants in Thailand, with most located around Bangkok and its vicinity. However, given Thailand's laggard local manufacturing performance, IS policy was not successful in its attempt to promote industrial deepening. Manufacturers could not find local suppliers with sufficient investment and technical capabilities. Consequently, they had to rely on imported intermediate goods, creating both a trade deficit and a balance of payments problem.

Thailand responded by shifting its industrial development policy to be more export-oriented in the mid-1980s. In addition, the Thai government undertook a series of currency devaluations, wherein the Thai exchange rate was devalued from 20 baht per USD during 1960 to 1980, to 27.16 baht per USD. The growth in

manufacturing export share grew rapidly after the devaluation, see Figure 1.B. The export-oriented industrialization policy, proposed by the Industrial Policy Committee, in 1984, had automotive production as its primacy focus (Poapongsakorn and Techakanont 2008, p. 211). Moreover, in order to attract Japanese investment, the government worked hard on convincing the Japanese government and investors that it would adopt an outward-oriented investment policy and avoid a nationalistic policy discriminating against foreign investors. The government adopted a strategy to utilize FDI as a locomotive to stimulate economic growth and nurture local firms.

FDI has been important for capital formation in Thailand. The structure of FDI inflows within the manufacturing sector is shown in Figure 2. Between 1970 and 1985, the average share of manufacturing for FDI was about 33 percent, with electrical appliances and transport machinery equipment accounting for a large proportion among manufacturing sectors. This trend became clear after the Yen appreciation in 1985 and after the financial crisis in 1997, at which time FDI surged significantly. The share of FDI for machinery and transport equipment has been around 10-25 percent in recent years. This evidence supports the argument that Thailand relies heavily on FDI to promote industrialization. However, the growth in FDI has been supported by macroeconomic stability in Thailand, e.g., the relatively low rate of inflation and a stable exchange rate, the commitment to trade liberalization in the early 1990s and a well-developed infrastructure, particularly with respect to industrial estates, roads, telecommunications and seaports (Kohpaiboon 2005, Poapongsakorn and Techakanont 2008). One of the most important government policies was the decentralization of industrial sectors into other provinces in order to promote regional development.

Figure 2 Structure of Manufacturing FDI and Share in some Key Sectors (1970-2007)



Source: Bank of Thailand, online database, available at www.bot.or.th

In line with its regional development objectives, Board of Investment incentives were revised and privileges were granted to firms according to their location in three General Industrial Zones (see Table 1). This revision was the major driver of industrial decentralization towards the eastern provinces. Industrial estates and developed infrastructure were important for MNEs when choosing a location for their new plants. According to Watanabe (2003), Japanese investors' behaviour in locating their production factories has coincided with the development of infrastructure in Thailand, especially the Eastern Seaboard Development (ESB) Plan. The ESB plan was initiated in the mid-1980s in order to implement the Thai government intention to establish an industrial cluster in three eastern provinces (Chachoengsao, Chonburi, and Rayong). Consequently, the eastern region became the second largest manufacturing sector behind Bangkok. Industrial activities, in terms of Gross Regional Product (GRP), in these two regions increased significantly between 1995 and 2005 (see Table 2). The

manufacturing sector of the eastern region was the second highest, after the central region, and its manufacturing sector is also highly diversified. The largest sub-sector is refined petroleum products, followed by automotive, petrochemical and machinery sub-sectors, respectively.

The ESB project received finance from several sources. In addition to the government budget allocated to ESB, Thailand was a recipient of a World Bank loan to construct its road and railway network (Poapongsakorn and Fuller 1996). Furthermore, Thailand received a loan from Japan under the Official Development Assistance (ODA) and Japanese ODA has played a vital role in the development of the ESB, especially through technical assistance in the construction of infrastructure from 1980s onwards (Watanabe 2003, p. 142). The ESB project has two main industrial areas, Map Ta Phut (for the petrochemical industry) and Laem Chabang (a commercial seaport and industrial estate). Once infrastructure construction was complete, many firms relocated to these areas and new industrial estates were established, i.e., Eastern Seaboard IE and Amata City IE. The location of these IEs, induced by industrial decentralization policy in the 1980s, was the critical factor for firms electing to locate in the same area. This has made the ESB an important part of the automotive cluster in Thailand (Poapongsakorn and Techakanont 2008). In the next section, we will describe this process in detail.

Table 1 Investors' Privileges in Accordance with BOI and Industrial Estates Authority of Thailand (IEAT) for Location in Three General Industrial Zones

	Zone 1	Zone 2	Zone 3
Corporate Income Taxes	100% exemption for 3 years	100% exemption for 7 years if location in IE	100% exemption for 8 years + 50% reduction for a further 5 years
Duties on Capital Goods (Machinery, parts etc.)	Pay 50%	Pay 50%	Free
Duties on imported raw material	Exemption for 1 year if exports at least 30%	Exemption for 1 year if exports at least 30%	5 year exemption if exports at least 30%; pay 25% for 5 years
VAT, Excise Tax, Surcharge (BOI), Import and Export Duty (IEAT)	Normal rates	Normal rates	Normal rates
Transportation, Electricity, Water	Not applicable	Normal rates	Double deduction from tax income for 10 years
Infrastructure Facilities	Not applicable	Not applicable	Deduction from taxable income 25%

Source : Industrial Estate Authority of Thailand, www.ieat.go.th

Zone 1 = Bangkok (Bangplee IE, Lad Krabang IE), Samut Prakan (Bangpoo IE, Gemopolis IE), Samut Sakhon, Nakhon Pathom, Nonthaburi, Pathum Thani.

Zone 2 = Ayutthaya (Bangpa-In IE, Saha Rattana Nakorn IE), Chachoengsao (Gateway City IE, Wellgrow IE), Chonburi (Amata Nakhon IE, Chonburi Bo-Win IE, Pinthong IE). Special zone 3 privileges apply to Chonburi (Laem-Chabang IE), Ratchaburi (Ratchaburi IE), Saraburi (Saraburi IE).

Zone 3 = Rayong (Amata city IE, Eastern IE, Eastern Seaboard IE, Map-Ta-Phut IE, Padaeng IE, Thai Singapore 21 IE, Asia IE) Khon Kaen Mini IE, Northern Region IE, Pichit IE, Southern IE.

Table 2 Sectoral Share of GRP by Regions

(Percent)

Region	1995				2005			
	All	Agriculture	Industry	Services	All	Agriculture	Industry	Services
North	100	18.20	29.87	51.93	100	18.07	31.88	50.05
Northeast	100	20.69	24.13	55.18	100	18.45	24.21	57.34
Central	100	7.11	66.04	26.85	100	4.73	77.24	18.02
East	100	7.51	67.58	24.91	100	5.20	72.96	21.84
West	100	17.02	36.74	46.24	100	16.81	36.83	46.36
Bangkok and vicinities	100	1.00	44.86	54.15	100	1.31	45.57	53.12
South	100	33.17	23.13	43.70	100	33.18	22.62	44.20
Whole Kingdon	100	9.40	43.03	47.57	100	8.68	47.29	44.03

Source : National Economic and Social Development Board, GRP

3.2 Pathway towards Cluster Agglomerations and Integration into Global Production Network of the Thai Automotive Industry

In the 1970s, it was at this time that the agglomeration of firms in the automotive industry developed. Automobile and auto parts producers located their plants in industrial estates in Bangkok and the central area, such as Samut Prakan province, due to the government policy encouraging foreign investors to locate in IEs. Their suppliers were located nearby in order to minimize transportation costs. These IEs were the first IEs that the Thai government created to attract foreign firms to establish their production facilities. This was the first step of agglomeration of part suppliers in Thailand; however, the clusters were rather small at that time (Lecler 2002).

During the 1980s, the LCR was revised and the requirements went beyond the assembly of automobiles. Policy makers imposed further restrictions such as the local sourcing of certain compulsory parts such as radiators, batteries, exhaust pipes, and parts for diesel engines. Localization on diesel engines was imposed in 1989 at 20 percent and the ratio was set to increase to 70 percent in 1996. Because of this policy, assemblers started to develop their supplier network and supporting industries in Thailand emerged. Local firms were nurtured and subsequently went on to develop their businesses. Nevertheless, the Thai government was quite flexible before enacting any regulation. Policy makers and assemblers normally discussed the possibility of increasing local content. In this way, Japanese carmakers could share their views with policy makers on the ratios for each part, to enable them to comply with changes in the LCR scheme (Siroros 1997). As a result, from the latter half of the 1980s, the agglomeration of automotive firms in Bangkok and its vicinity further increased.

As discussed earlier, with respect to the automobile industry, IEs in the eastern provinces were quite successful in attracting car makers and part suppliers to

agglomerate. Japanese corporate investment became concentrated in Chonburi, with auto makers such as Mitsubishi and its suppliers in Laem Cha Bang IE, Denso, Siam Toyota, and other part makers in the Chonburi IE, while Western automakers (AAT, GM, and BMW) invested in Rayong (Eastern Seaboard IE), followed by western part suppliers such as Visteon, TRW, and Dana. Some Japanese part makers also invested in these IEs to supply parts to western manufacturers. Significant growth in automobile projects has been realized in Chonburi and Rayong since the 1990s.

Geographically, the establishment of new car manufacturing factories has led to a change in the distribution of manufacturing activities over time. Before the 1990s, Japanese parts suppliers tended to locate in the central area, especially the Bangkok and Samut Prakan areas. Since the 1990s, there has been significant growth in newly established suppliers in the eastern provinces. However, if the distribution of firms in automotive-related companies is taken into consideration, Bangkok and Samut Prakan are still the most important locations (see Table 3). Recent expansion in production capacity by many assemblers, such as Isuzu, Mitsubishi, AAT, and Toyota's establishment of a third factory, are in the eastern provinces. Thus, it can be said that the eastern region of Thailand is becoming another major strategic location for Thailand automobile production.

Automakers' strategies in selecting new production locations influence their suppliers to relocate or establish new plants in the same area in order to minimize transportation costs. According to Lecler (2002), locations in ESB were selected for many reasons: investment incentives (because these areas are in Zone 3), their proximity to port facilities (Laem Chabang), the proximity to part suppliers that were established previously in old IEs such as Lad Krabang, Chonburi, or some firms located outside IEs but on the Bangna-Trad road which provides easy access to their facilities,

cheap prices and availability of land for creating supplier parks, and an abundant workforce. The location of major Japanese part makers in

Table 4 is evidence of the agglomeration of part suppliers in different locations during each period. Before the 1990s, parts suppliers were clustered in the central region of Thailand. Then, new factories spread to the northern part of Bangkok and finally to the Eastern Seaboard area after the 1990s. Table 5 shows that most of the factories are in Bangkok and the eastern region. Bangkok has the largest number of automotive factories outside the IE, followed by the eastern region.[3] This may be one reason that influences the decision of multinational car makers to choose Thailand, particularly the eastern region, as part of their global production network (GPN).

Table 3 Numbers of Automotive Companies in Thailand in 1999

Province	No. of companies	Share of companies
Bangkok	406	42%
Samut Prakan	188	20%
Pathum Thani	52	5%
Samut Sakon	45	5%
Nakhon Pathom	17	2%
Nonthaburi	13	1%
Central Thailand subtotal	721	75%
Chonburi	64	7%
Rayong	58	6%
Chachoengsao	30	3%
Eastern seaboard subtotal	152	16%
Ayutthaya	43	4%
Natkhon Ratchasima	17	2%
Others	25	3%
Others areas subtotal	85	9%
Total	958	100%

Source : Lecler (2002), Table 2.3.

* Including non-production functions such as head office operations.

[3] Although there are more automotive factories outside the IEs, many of them are garage service operators and local parts suppliers. Most of the parts factories in the IEs are foreign-owned and relatively larger than those outside the IEs.

Table 4 Location of Major Japanese Parts Suppliers in Thailand

Location	1969	1970-79	1980-89	1990-95	1996-98	Total
Bangkok	3	6	6	9	8	32
Samut Prakan	4	7	11	4	4	30
Chonburi	-	1	1	12	6	20
Rayong	-	-	-	4	16	20
Pathum Thani	1	1	8	4	1	15
Chachoengsao	-	-	3	3	2	8
Ayutthaya	-	-	-	5	2	7
Others	-	-	2	3	6	11
Total	8	15	31	44	45	143

Source : Lecler (2002), Table 5**,** p. 808

Table 5 Number of Factories in and outside IEs by Region in 2006

Region	Non-Industrial Estates (2005)		Industrial Estates (2006)	
	Total	Auto parts	Total	Auto parts
Bangkok & Metropolitan	50,510	1,203	859	123
Central	11,393	169	220	31
East	7,359	317	1,140	306
Northeast	41,163	42	1	0
South	9,823	14	22	0
North	15,021	22	87	3
Total	**135,269**	**1,767**	**2,329**	**463**

Source: Industrial Estate Authority of Thailand, Department of Industrial Works

In four decades, Thailand's automotive industry became export-oriented and a part of the GPN of world class carmakers. As discussed earlier, the Thai automobile industry was promoted in line with the country's import substitution policy and investors received an investment promotion from the Board of

Investment (BOI). Tariff protection and other non-tariff barriers, such as an import ban, successfully enticed several automakers to Thailand. The government implemented a more rationalized policy, aiming at increasing the localization of parts and components. Carmakers were required to limit the number of models in production (to increase the number of vehicles per model) and to use local parts up to the level specified in Local Content Requirement (LCR) regulations, which was increased incrementally over time.[4] Automobile production and sales grew significantly in the 1990s due to two major reasons. On the one hand, the appreciation of the Japanese Yen in 1985 encouraged Japanese investors and part makers to expand their production in Thailand. On the other hand, the Thai government committed to liberalizing the auto industry, e.g., the deregulation of the automobile industry in the early 1990s and the abolishment of the Local Content Requirement regulation in 2000.

The Asian Financial Crisis caused a serious impact on the manufacturing sector, including the automotive sector, but the industry was resilient and rebounded quickly. The aftermath of the economic crisis proved that Thailand has strong potential to be an export hub. Despite the severe shock entailed, many assemblers, such as Mitsubishi, Toyota, Auto Alliance (a joint venture between Ford and Mazda), GM, and Isuzu, tried to increase their exports and later decided to use Thailand as their export base. Production capacity expanded considerably after 2000. In 2007, annual production was 1,301,849 units and total exports were 690,100 units. This was an important milestone for the Thai automobile industry.

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[4] The LCR was set at 25 percent in 1975 and increased to 54 percent for passenger cars and 70 percent for pickup trucks until December 31, 1999.

The fact that assemblers could swiftly turn their excess production capacity into exports indicates that Thailand's manufacturing capabilities accumulated in the past were sufficient to achieve international quality standards at a competitive price. It can be argued that earlier government policies were successful in fostering the process of industrialization, under the series of protection policies, which attempted to streamline the process incrementally. The government always included the business sector, especially Japanese car manufacturers, to ensure that regulations were feasible before they were officially declared as government policy (Poapongsakorn and Techakanont 2008). In this adjustment process, Japanese carmakers have played crucial roles in the development of local automobile production and supporting industries in Thailand. Since 2000, automobile assemblers have included Thailand as one part of their global production network. Thus, they need to improve their operation and management to be leaner and their supply chain network more consolidated.

4. Cluster and Interactive Learning in Thailand

According to Ernst (2004, p. 93), a global production network (GPN) covers both intra-firm and inter-firm transaction and forms of coordination. Hence, it increases the need for knowledge sharing among members in the network. Specifically, this will expand inter-firm linkages and create the need for technology transfer, at both 'intra' and 'inter-firm' levels. Locally based suppliers have new opportunities to upgrade their capabilities.[5] This section will report research findings on technology transfer at product

[5] Knowledge sharing at both levels in essence is similar to "interactive learning" that was emphasized as one important aspect of "capability upgrading", suggested by other strands of literature, such as regional system of innovation, open innovation, localized learning, and agglomeration economies.

development and design capabilities, by taking Toyota IMV project as a case study, the characteristics of GPN and 'interactive learning' or knowledge sharing in the production network from both assemblers' and suppliers' points of view, and collaboration in R&D activity in Thailand's manufacturing sector.

4.1 Technology transfer in product development and design to Thailand

Thailand's automotive industry has gradually developed and ultimately become a part of the GPN of many assemblers. Our earlier discussion made it clear that this is possible because of the well-developed supporting industries in Thailand thanks to government policies and Japanese firms in creating supplier networks. This enables assemblers to launch new models for both domestic and export markets. The Thai automobile industry has become export-oriented, and has been integrated into part of the global production networks of pickup trucks by many manufacturers. Key exporters in 2007 were Toyota, Mitsubishi, Auto Alliance, Isuzu, and GM.

According to Techakanont (2008), Toyota's IMV project is perhaps the best example of a GPN because the production started almost at the same time at its four main production bases of Thailand, Indonesia, Argentina and South Africa. The project supplies vehicles to countries in Asia, Europe, Africa, Oceania, Latin America and the Middle East. In addition, the project also includes the production of some major components in various locations, such as diesel engines in Thailand, gasoline engines in Indonesia and manual transmissions in the Philippines and India, and their supply to the countries in charge of vehicle production (see Techakanont 2008). An important implication of this development is that it is necessary for assemblers, the lead firm of its network, to create and diffuse their organizational 'routines' to their suppliers. In other words, some knowledge (technology) has been shared among firms in the production networks (Poapongsakorn and Techakanont 2008). In this section, we now turn our

discussion to understand how technology in research and development and design are transferred when a foreign assembling firm plans to launch a new model of automobile in another country.

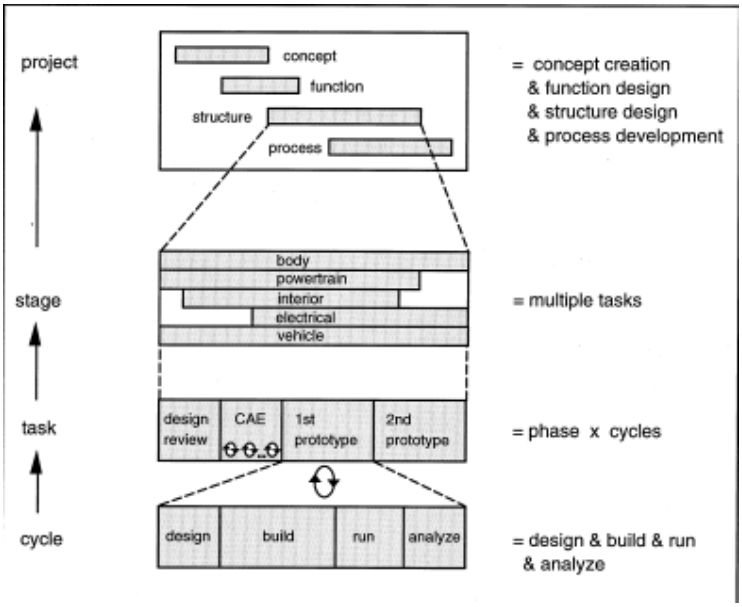
Before transferring the manufacturing of automobiles to overseas production base, the most important task, i.e., product development, must be accomplished. Product development activity may be divided into four major stages, namely, concept generation, function and structure design,[6] process development (or process engineering), and, finally, when these activities were complete, mass production will be launched (as shown in **Figure 3**).

In the case of Toyota IMV project, this study found that the pattern was resemble to Aoki (1988) and Clark and Fujimoto (1991) findings that Japanese automobile manufacturers develop new products and/or new models in Japan, at their R&D center, in close collaboration with many part suppliers. Intensive information exchange between the assembler and parts suppliers takes place at this stage, as the assembler relies on suppliers' engineering capability in both parts design and development. This process is usually performed in Japan because the assembler can maintain an efficient flow of information with all the suppliers. Mass production would have no serious problem if it were launched in home country, however, stiff competition in the world market forces firms to launch their production in other low-cost locations that have sufficient engineering capability. The separation between development and

[6] According to Clark and Fujimoto (1991), these two stages may be referred to as "product planning" and "product engineering." In a recent study, Thomke and Fujimoto (2000) explain these two stages were normally carried out simultaneously, hence, it is sometimes known as "simultaneous engineering."

production stages requires the assembler to spend more resource to transfer technology to its affiliate as well as to local suppliers.

Figure 3 Stages of Product Development Activities



Source: Thomke and Fujimoto (2000), Figure 2, p. 131

Toyota's IMV project was the first project for TMT to launch 5 newly designed models. From its formal announcement, it took less than three years for launching all models in 2004, which was considerably shorter than other projects in the past. The challenges of this project were local customization, which hinges upon proper management of the economics of product development and manufacturing (Osono et al. 2008, p. 100). Comparing with pre-IMV project, there were three major changes in TMT business; 1) production volume increased substantially (from 88,000 unit per year in 2000 to 208,000 in 2004, 2) OEM parts export rose 4 times to support 9 Toyota production bases, and 3) model variation surged from 44 to 281 models.[7]

[7] Interview with an EVP of TMT on May 29, 2009.

In the case of IMV, the preparation stage can be divided into five phases, from development stage, production preparation stage, trial, mass production for domestic market, and mass production for export. Interview with executive staff of TMT revealed that intensive technological transfer in product engineering stage, such as computer-aided design (CAD) and digital engineering, is one main factor accounting for this success. TMC was confident in their strength that the prototypes for all models were developed and tested in Japan, thus to transfer the trial production to Thailand should be under controlled. Nevertheless, Thai engineers and management staff members were sent to headquarter through Intra Company Transferee (ICT) program to participate the development of new parts for new models. Exposing these members at the HQ where development and testing processes were performed help Thai staff members understand how to handle if problems arose during the trial production.

What they learned in Japan? Based on several interviews by this author, there was evident that some assemblers already made the progress in transferring some aspects of product and process engineering to their employees, such as capability to revise some engineering design of body parts and some components that are not safety parts. It should be noted that, based on observation of this author, Thai engineers were neither involved in the design nor development of new parts for IMV project. They worked on new projects to be launched in the United States. Toyota included them to the current project (at that time) and expected that Thai staff members could accumulate the real experience of R&D for new model. Interviews with Thai engineers who were being trained at the headquarter plant in Japan indicated that they were able to do analysis and revise some engineering changes. They worked with Japanese R&D engineer at Toyota Technical Center and learn the R&D activities on the job. They did not engage in product design, however. They were requested by their supervisor to

develop some parts for new model. every 'engineering change notice' has to be written systematically and thoroughly evaluated before submission, though final assessment and approval are done by engineering division at headquarter. After ICT program, these engineers went back to Thailand and worked as leaders in part development and assessment at TMAP-EM. Their roles are as their supervisor in Japan, but they also serve as a "technical window" for Toyota Technical Center in Japan. Engineers at TMAP-EM can do the part development process by their own and can give suggestion to part suppliers in Thailand, yet the final decision has to be approved by the headquarter. Therefore, it can be said that TMC had partially transfer R&D activities to Thailand by involving Thai engineers in the R&D center in Japan.

As described in technology transfer literature, most of technologies and skills are embodied in organization routine and human resources and they are difficult to transfer. For Toyota, it has its own development system, called "Toyota Development System."[8] Therefore, it is necessary for TMAP-EM to have their engineers worked and trained in Japan. On-the-job training was the most effective method to transfer 'tacit' skill of Japanese expert to Thai engineers through 'socialization' process. After learning such skills, Thai engineers have to transform their skill into a more explicit form, such as to develop documents into Thai language (externalization) or to improve the knowledge they have learned into a new standard (combination). This set of explicit

[8] For details about product development of Toyota, see Fujimoto (1999), Amasaka (2002) and Liker (2004).

knowledge would then be crucial for sharing with and training to other staff at TMAP-EM (internalization).[9]

In addition, Toyota set up a goal for 'knowledge externalization' in the Toyota Way 2001. This system aims at conversion of 'tacit knowledge' into an 'explicit' form of knowledge. Workers are encouraged to write down the knowledge they have embodied, thus, this best practice can be shared among members both in Japan and overseas operation. As reported in Techakanont (2005), Toyota set up "Global Production Center" (GPC) in July 2003 in order to transmit best production practices to large numbers of mid-level plant managers from overseas and Japan. In 2006, Toyota expanded this activity to Europe (E-GPC) and Thailand (AP-GPC) in order to intensify "Made by Toyota" philosophy.[10] This is another example of technology transfer to Thailand in product and process engineering levels.

4.2 Characteristics and Knowledge transfer in Production Networks

There are two important characteristics of the emerging GPN, i.e., intensified global sourcing and adoption of the modular system (Sturgeon and Lester 2004). One of the consequences is that suppliers, particularly those producing larger and bulkier modules, need to develop closer relationships with automakers or have to locate their

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[9] Nonetheless, it can be expected that the main function of R&D activity will be performed in Japan. The centers in Thailand and in Australia would play supportive roles, as indicated in a company's document, that TMAP-EM's functions included "survey and research about consumer preference about style, technology, color, and material for parts. Then this information will feed to the R&D center in Japan to develop and design new automobiles."

[10] http://www2.toyota.co.jp/en/vision/globalization/gpc.html

plants near those of the automakers.[11] Proximity to the customer can help shorten shipping time and reduce transportation costs, especially for bulky parts and most large modules that need to be sequenced on the assemble line. The other consequence of the adoption of module systems is that many first-tier suppliers have begun to acquire or enter into the joint ventures with other related parts businesses as well as to establish new plants in the emerging markets. Such moves enable them to gain the ability to deliver parts and modules just-in-time on a global basis. To understand the characteristics of the automobile GPN in Thailand, the author tries to describe the role of knowledge sharing in the case of Toyota Motor Thailand (TMT). Information was obtained through questionnaire survey, interview with Toyota Motor Thailand, and factory visits to parts suppliers between 2003 and 2008.

Dyer and Nobeoka (2000) identified three institutional innovations in the creation of the network and in facilitating inter-firm knowledge sharing, i.e., supplier association, knowledge transfer consultants and small-group learning teams (or jishuken). Information obtained from interviews with Toyota executives confirms that Toyota Thailand has also adopted similar institutions in Thailand. Interview results indicate that Japanese firms need to enhance the productivity of their suppliers and have invested in some important activities that help raise its supply chain in Thailand up to

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[11] The increasing utilization of global sourcing and module system in the motor vehicle industry has important implications for the Thai parts suppliers. Currently, there are now only a small number of Thai firms as the first-tier suppliers capable of providing some module systems for the automakers. Yet, Thai suppliers produce only module systems labor-intensive parts, such as seats, cockpit module and trimming. They do not yet have technical capability to assemble the knowledge intensive components such as ignition, chassis electrical systems, drive train system (i.e., engines, axles and transmission), rolling chassis, etc.

the standards of the GPN. Toyota began to introduce a Toyota Cooperation Club (TCC) and established a training centre in 1982, when there were around 25-35 supplier members. This number increased to 109 members (as first-tier suppliers) in 2007.[12] Toyota has utilized TCC activity as a means to diffuse its efficient production management system, called Toyota Production System, to suppliers. Toyota's production network facilitates knowledge sharing among suppliers in the network, similar to their achievement in the US.

The Toyota Cooperation Club (TCC) is responsible for the sharing of explicit and tacit knowledge. Not all suppliers can join and benefit from the club, however. Only suppliers who have maintained a long-term relationship with Toyota will be admitted as the TCC members. As a member, suppliers can receive a consulting service on the Toyota Production System. This is a free-of-charge service but suppliers' top management must show their commitment in learning and improving their production management capabilities. Then, Toyota will send well-trained consultants to transfer tacit know-how regarding the Toyota Production System at the suppliers' plants. But knowledge transfer is not the only objective. The consultants are acting as "the catalysts for creating a norm of reciprocal knowledge sharing, and a feeling of indebtedness and openness within the supplier network" (Dyer and Nobeoka, 2000). Currently the Thai staff is also responsible for providing TPS training for the parts companies in other

[12] At Toyota, suppliers are divided into several types; including parts suppliers (or first-tier suppliers, which is the focus of this study), facility tools, packing material, direct material (e.g., paint, oil), indirect material (for use in manufacturing site), and logistics (transportation service for parts and material). According to the TCC Annual Book, in 2007, there were 145 TCC members. However, this number also includes other types of suppliers.

ASEAN countries. This activity is evidence of 'interactive learning' at the vertical level, i.e., between local suppliers with their customers (Toyota and other assemblers).

The third institution is small group learning activity to maximize the willingness and the ability of suppliers to learn and to share the specific tacit knowledge with each other team members. The institution is very effective in developing strong ties among team members through the formal "core group" activities and informal social networks. This practice is unique to the case of Toyota. Other Japanese firms seem to have less active supplier development activities. In 2007, we observed that American (GM and Ford) and European (BMW) carmakers did not utilize similar institutions of knowledge sharing. They provide necessary technical support required for the new car models. Based on this observation, it can be argued that the Japanese automakers tend to rely extensively on multi-tiered supplier networks and have established long-term relationships based on trust and rent sharing. Thus, from RIS and open innovation perspectives, local firms can benefit from inter-organizational networking (interactive learning) at both the horizontal and vertical levels. The role of Toyota as the conductor of this activity is vital to maintaining the effectiveness of knowledge sharing within the network, although this was undertaken to maximize their own benefit.

4.3 Characteristics and Benefits of Knowledge-sharing in Production Networks at the Firm Level

We will now turn to answer what type of benefits local firms realized from participation with customers (assemblers). Based on questionnaire survey results, we received only 18 questionnaires returned, out of 250 sets sent out in 2007. Despite a small number of sample firms, their answers can represent some aspects of the characteristics of production networks, because they are currently supplying parts to major assemblers in Thailand. Some salient characteristics of the production network of

the sample parts suppliers are shown in Table **6**. First, the main factor leading to their recruitment as partners in a production network is that the company produces quality products and possesses reliability (38.9 percent), and trust based upon long-term business relationships with customers (22.2 percent). Second, 15 firms out of 18 (83.3 percent) of the sample companies are members of auto clubs set up by the auto makers or members of the parts producers association. Only 16.6 percent of the sample is neither members of the auto club nor members of the parts producer associations.

From the 15 firms that responded as being a member of an assembler association, 12 firms are member of TCC. Therefore, research findings can reflect how Toyota utilizes 'supplier association' or 'supplier club' as a method of sharing and diffusing knowledge among members. All suppliers stated that they received training; 11 out of 15 firms (83.3 percent) state that they receive regular training from the auto clubs, while four firms (26.7 percent) receive occasional training services. Interestingly, three firms reported that they had received on-site technical advice from automobile assemblers. A Thai supplier disclosed that, in 2006, Toyota had sent two experts to give technical advice at its factory for one month, and the result was very satisfying. This company was able to improve productivity as well as product engineering capabilities (such as VA/VE and engineering change). This fact thus confirms the willingness to transfer technology or to diffuse knowledge to supplier in its network, i.e., the Toyota Cooperation Club.

Table 6 **Some Characteristics of Automotive Production Network in Thailand**

Question	Percent
1. What are reasons that your company being selected as part of the network	
- Product quality and reliability	38.9
- Trust and long-term relation	22.2
- High potential production	5.5
- Efficient management system	5.5
- Not answer	27.7
2. Is there an auto club or parts association	
established by the car makers?	
- Yes, and the firm is a member (15 out of 18 firms)	83.3
- Yes, but the firm is not a member (1 out of 18 firms)	5.5
- Not answer (2 out of 18 firms)	11.1
3. Does the auto-maker regularly organize production-related	
activities with you (parts suppliers)? (15 firms that join association)	
- Training (a) regularly	73.3
(b) occasionally	26.7
- Sending advisors (a) yes	16.6
(b) no	83.3
- Executive meeting (a) yes	100
(b) no	0
- Visiting the best practice factories	
(a) Yes	86.7
(b) No	13.3
- Exchanging knowledge on production, design, process	
(a) Yes	86.7
(b) No	13.3
4. Benefits from being part of the auto network (multiple answer is allowed)	
- Receive technical assistance from assemblers	86.7
- Economies of scale	73.3
- More clients/market diversification	26.6

Source: Survey of Auto Parts Firms in the ESB Area during January and February 2007

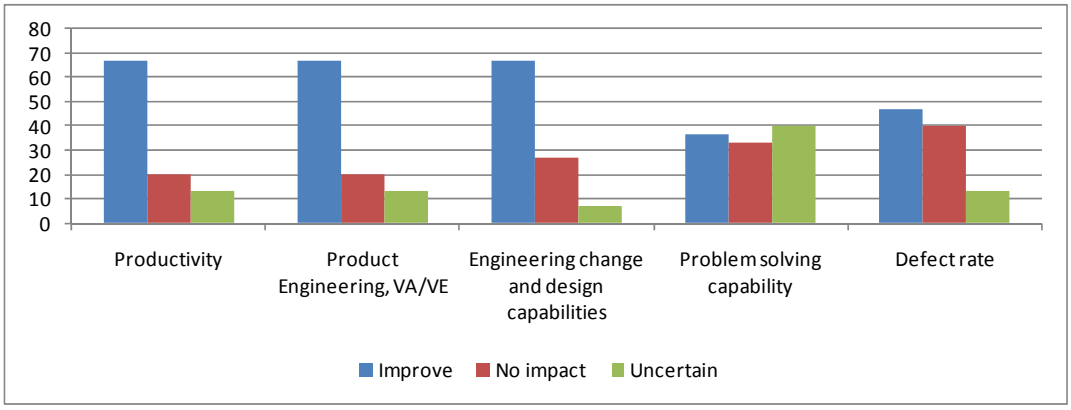
Suppliers can also benefit from study group activity and had visited best practice factories to learn how to solve their production and other related problems more efficiently (86.7 percent) and to exchange knowledge about production, design and production processes with other club members (86.7 percent). This is consistent with benefits derived from being a production network member, including receive technical advice from automakers (86.7 percent). If they could find ways to improve productivity or to reduce defect rates, they have to share their findings with other network members. Because knowledge exchange is valuable for suppliers, especially the chance to receive consulting service or technical assistance from assemblers, they recognize the need of reciprocity. In addition, all firms reported that auto makers regularly hold executive meetings, which are a forum for discussing future business, as well as a means for assemblers to observe and evaluate top management's commitment on knowledge sharing activities. These characteristics are consistent with a study of the knowledge network of Toyota in the U.S. (Dyer and Nobeoka 2000).[13]

Figure 4 identifies the benefits from the production network. As reported earlier, the major benefits derived from being a production network member are technical advice from auto makers and economies of scale from a larger volume of business. This explains why network membership can significantly enhance the productivity and improve product engineering, and design capability (67 percent of the sample firms). In sum, being part of an assemblers' production network offers considerable opportunities for suppliers to learn and improve their technological capabilities. Findings from this study are consistent with the work of Techakanont and Terdudomtham (2004b) that

[13] This implies that the Toyota production system has been adopted both in developed and developing countries.

described the existence of "inter-firm technology transfer" in the Thai automobile industry. Part suppliers can learn new technology or production methods from having business relationships with assemblers. Based on our observation, interactive learning is confined to suppliers in the network. As a result, this norm has not yet diffused and embedded in 'social capital'. Nevertheless, Toyota is now promoting TPS activity to other firms in the industry through a cooperative project called "Thailand Automotive Human Resource Development" (AHRDP). In this project, other Japanese firms, Honda, Nissan, and Denso, participate and each will be responsible for transferring different technology to auto parts firms in Thailand. This topic deserves further investigation.

Figure 4 Benefits from being Part of Automotive Production Network



Source: Survey of the Auto parts Firms in the ESB area during January and February 2007

Note: (15 out of 18 firms answer these questions)

Discussion so far has revealed that the automotive industry in Thailand has developed because of the government intervention and response by private firms. Not only can collocation of firms in a close geographic area, in the ESB area and the central part of Thailand, promote agglomeration economies and knowledge sharing activity, many assemblers have upgraded the technological level of their subsidiaries in Thailand. As reflected by their recent investment strategies, some manufacturers have begun to invest in R&D in Thailand. For example, Toyota Motors set up 'Toyota

Technical Centre Asia Pacific Thailand' with an investment volume of almost 100 million US$ for technical development facilities. Honda also set up an R&D unit in Thailand. Nonetheless, the R&D activities of the two companies focus on modification of their already designed products to fit local demands and international standards (Intarakamnerd and Charoenporn, forthcoming).

4.4 R&D Cooperation of Thai Firms

In retrospect, industrial policy of Thailand has not paid attention to the development of indigenous technology capabilities as an integral factor in the process of industrialization (Sripaipan et al., 1999, p. 37, Intarakamnerd et al. 2002). There is no explicit clause in investment promotion policy that actively forces or encourages foreign firms to transfer technology and upgrade the technological capabilities of local firms. As a consequence, the intensity of links between producers and users and between producers and suppliers are relatively weak (NSTDA, 2002). Knowledge-sharing in the vertical interaction along the value chain has been melded by competitive pressures in domestic and global markets. As shown in the automotive industry, knowledge-sharing is rather limited within the supplier network of MNEs, while the horizontal relationship between firms in the same or related industries is viewed as relatively unimportant. In addition, co-operative consortiums among firms to research particular technology or products are very rare in Thailand (Intarakumnerd et. al., 2002).

A number of empirical studies have explored the determinants of R&D cooperation (e.g. Kleinknecht and Reinen, 1992; Fritsch and Lukas, 2001; Tether, 2002; Belderbos et al. 2003). Major motivations of firms to encourage specific R&D cooperation include incoming knowledge spillover, the establishment of new relationships, access to complementary resources and skills, technological learning, and keeping up with major technological developments, together with R&D cost sharing

(Caloghirou and Vonortas, 2000). A major finding of recent work is that the goals and the determinants of R&D partnerships differ depending on the type of cooperation and partner. It is important to develop much more significant technology development interaction between firms in order to enhance the competitiveness of existing clusters and value chains.

Many previous studies point out that Thai firm are lagging behind in terms of deepening their technological capabilities. However, higher competition in the global market and the economic crisis started in 1997 has, to some degree, led to the changing behaviour of Thai firms. Businesses became more aware of both prudent investment and the importance of R&D and technology. The government realized the weakness of the Thai science and technology base and attempted to upgrade the national system of innovation. Several policies were implemented in order to address the weaknesses and fragmentation of the national innovation system (NIS), defined as being the interactive system of existing institutions, private and public firms, universities and government agencies, to encourage technological capability development in the Thai manufacturing sector. They have started to use the concept of enterprise-based technology development and NIS to promote technology development in the Thai manufacturing sector. The Thai government tried to implement cooperation among firms, public research institutes and universities.

To understand 'interactive learning' between local firms and other economic entities and institutions emphasized in this strand of literature, this study will explore the characteristics of R&D cooperation among different types of partnership by using

"The Thailand R&D/Innovation Survey[14]" and the work of Charoenporn (2006). The survey invoked some fundamental clauses from the Oslo Manual (OECD, 1996). For this survey, research and experimental development (R&D) in industry is defined as creative work which is undertaken on a systematic basis in order to create new or improved products, processes, services or other applications. Technological innovation is defined as the capability of firms to use their technological knowledge, skill and experience to develop and produce new products, new production process or new services that respond to market demand (OECD, 1996). Thus, the definition of innovation is broad and not confined to the results of basic R&D. This definition is suitable for studying R&D activities of firms in technology-follower countries, including the case of Thailand (Forbes and Wield 2000).

The Innovation Survey 2001 covers a good proportion of medium and large enterprises in Thailand. This survey received 1,449 completed questionnaires from a total population of 14,870 firms that have sales of at least 12 million Baht (Companies whose sales are below this level are regarded as being small enterprises). Thus, it can be a good representative sample for this purpose.[15] It was found that 154 firms carry out

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[14] The survey was conducted by The National Science and Technology Development of Thailand (NSTDA). The pilot survey of Thailand R&D/Innovation Survey was begun in 1999 followed by a survey in 2001, 2003, and, most recently, 2008. Unfortunately, this database is not disclosed publicly. Therefore, this study is based on the Thailand R&D/Innovation Survey in 2001, used in Charoenporn (2006).

[15] It covers 9 industrial sectors mainly fabricated metal products, machinery and equipment (101 firms); chemicals and chemical products (72 firms); and the food and beverage sector (61 firms). The companies are on the average 22 years old. Half of the sample is comprised of wholly Thai-owned companies, while 24.8 percent are majority foreign-owned companies. About 40 percent of the sample firms have their own

R&D and 220 firms undertake other innovation activities. [16] The survey result reveals that the key features of the R&D activities of Thai firms, in terms of budget allocation, concentrated in 'experimental development' activities and for 'product-oriented' purposes, while innovative activities were acquisition of machinery and equipment, which is linked to product and process innovation. This indicates that most R&D expenditure was allocated for incremental improvement in firms' products and processes.

The main objectives of firms' innovation include improving product quality, learning about new technology, reducing production cost, extending product range/improving cycle time and increasing market share. This evidence confirms the suggestions of Forbes and Wield (2000) that latecomer firms in the late-industrializing countries, like Thailand, should have different modes of technological capability development than firms in advanced countries by focusing on incremental innovation, process innovation (for cost cutting), shop-floor innovation, and by having a different role of R&D. With Thai firms, acquisition of new vintage machinery, embedded with a higher level of technology, is a means to improve overall production efficiency and productivity. The survey result indicates that only a very small number of Thai firms utilized external technology for their innovation.

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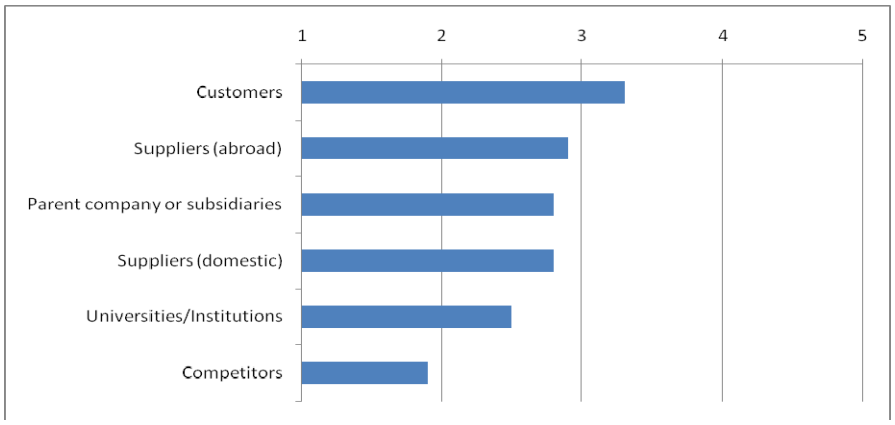
brand name products, i.e., original brand manufacturing or OBM, and on average these firms exported about 40 percent of total sales in 2001.

[16] In this survey, innovative activities are defined as, 1) Acquisition of machinery, equipment & software linked to product & process innovation, 2) Acquisition of external technology linked to product & process innovation (e.g. patents and licenses), 3) Industrial design and engineering, market research & marketing expenses linked to product & process innovation, and 4) Training directly linked to product & process innovation.

Regarding cooperation in R&D activities in the Thai manufacturing sector, the Innovation Survey asked the importance of several sources of knowledge and information to a firm's R&D and innovation activities, i.e., customers, suppliers, competitors, technological institutions, universities, patent disclosures, fairs and exhibitions. Thus, this list includes vertical, horizontal, and institutional linkages for interactive learning, as suggested by 'open innovation' and 'regional innovation system'. The survey result is shown in Figure 5.

Figure 5 Major External Sources of R&D Cooperation of Thai Firms in 2001



Source: Calculated by the author, based on data from Innovation Survey 200

It is found that vertical linkages are important and most of the sample firms have considerable cooperation with their customers and foreign suppliers, while the role of innovative supporting organizations, such as universities or technology institutions is rather inactive in the Thai context. However, this may not reflect that the sample firms are undertaking cooperative R&D with their customers or suppliers, but information received from customers and suppliers are regarded as the most important sources of knowledge for firms' R&D activities. This may be due to the nature of manufacturing activities of firms operating in Thailand as part suppliers or OEM producers (for both parts and finished products). It is not surprising to observe that the sample firms are carrying out cooperative R&D with their parent company or subsidiaries. This point is

consistent with the results discussed in previous sections and in a recent study on the technological upgrading of 15 MNEs' subsidiaries in Thailand by Hobday and Rush (2007), in that upgrading local capabilities is MNEs corporate strategy. Cooperation in R&D activities is an important strategy when upgrading operations in Thailand to a higher position within the global value network.

In the Thai manufacturing sector, the main reasons for R&D cooperation are to initiate new product knowledge, know-how transfer, financial support, and building up long-term relationships, rather than to reduce the risks and costs associated with R&D activity. They engage in R&D cooperation, or having interaction, with customers and/or suppliers in order to gain access to new information and receive know-how transfer which would shorten the time to market. Subsidiary firms in Thailand still rely on the support of their parent company. Firms having R&D cooperation with R&D institutes/universities aim to obtain know-how transfer, but not for sharing or reducing risks and costs, reducing time to market, and entering new technology fields. Unlike the experiences in NIEs, R&D institutes or universities in Thailand have not yet functioned as new technology providers.

What determines R&D cooperation?[17] Charoenporn (2006) was the first study to analyze this question systematically in the context of Thailand, by using data from the Innovation Survey 2001. He found that R&D cooperation has a positive relationship with successful innovation (measured by the percentage of total annual sales from R&D

[17] To measure the degree of R&D cooperation as dependent variable, the study asks the question of how intensely do firm cooperate with external parties including customers and buyers, locally-owned supplier, parent/ associate firms, and public R&D institute/ university in firm's R&D. It was collected in Likert scale ranking from 1 (not important) to 5 (very important).

related products and processes). The study found that the level of incoming knowledge spillovers, internal R&D capabilities and absorption capabilities has a positive impact on the probability of firms engaging in cooperative R&D with external sources. His statistical analysis suggests that absorptive capacity is one precondition for R&D cooperation and large firms, which have in-house R&D divisions, tend to have a high tendency to cooperate with external partners (Charoenporn 2006). This is consistent with the "two faces" of R&D, proposed by Cohen and Levinthal (1989), that R&D not only creates new knowledge, but also enhances the firm's ability to learn effectively from their environment and from the work of others.

In addition, he found that firms operating in some industries, such as the manufacture of chemical products, food and beverages, non-metallic products and basic metals, has more intensity of R&D cooperation than others (Charoenporn, 2006). It can be interpreted as a positive relationship between technological opportunity and R&D cooperation, i.e., firms having a higher technological opportunity will be more likely to have co-operative arrangements for innovation. Technological opportunity has two dimensions. On the one hand, it can be considered from the nature of production or product technology, such as petrochemicals, automobiles and parts, hard disc drives, electronic devices, all of which require state-of-art production techniques. On the other hand, it can be referred to in the context of the nature of local comparative advantage or embedded 'social capital', in which agriculture has long been the main activity of Thai people. This may be an explanation for firms in the food-processing industry having high R&D cooperation. This may be explained by the existence of localized capability that underpins such cooperative R&D activities in this industry, as suggested by Malmberg and Maskell 2006).

In Thailand, the roles and strategies of MNEs seem to be shifting towards a greater localization of 'deeper' technological activity, resulting in the necessity to upgrade the technological capability of their subsidiaries. Intense competition in the global market seems to be a main driving force for the need to upgrade the technology of their operation more than in the past. As confirmed by evidence in the automotive sector, establishment of an R&D centre in Thailand is a clear example of this active effort. Thus, it is expected to generate significant spillovers to the rest of the economy, through backward and forward linkages. Government intervention can raise the benefits and reduce the costs of cooperating (using) domestic suppliers. Building and supporting knowledge service centres, competence centres, business campus, and different networks and venture capital foundations, therefore, can help match private firms and public institutes and, thereby, reduce search costs.

In conclusion, industrial innovation in Thailand can be explained by the concept of 'regional innovation system' and 'open innovation', which emphasize the importance of interactive learning. Results described earlier suggest that several modes of cooperation are complementary and are important for the innovation of the sample firms. However, firms' motivation to undertake R&D cooperation with different types of partner differed. Firms with foreign ownership tend to have stronger cooperation with players within the supply chain (customers and suppliers), as well as their parent company. Domestically owned firms seem to have weaker linkage at both vertical and horizontal levels, but they tend to cooperate with external universities and R&D institutes. One possible reason is that they are not part of the network of final product producers, most of them are foreign firms, hence, they have less chance to learn and benefit from MNEs. Therefore, this suggests that the government should promote and

upgrade the role of public R&D institutes because it is an important source of technology for local and indigenous firms.

5. Conclusions

In this paper we have discussed the evolution of clusters and emphasized the analysis of 'interactive learning' in the Thai economy. Our analysis was based on synthesizing key concepts constituting 'interactive learning', which include clusters and agglomeration, (regional) innovation systems, open innovation, and localized learning. Discussion was traced back to the early stage of Thai industrialization, in which market imperfections prevailed, in order to shed light on the role of government intervention and response of businesses. With a virtually nonexistent industrial background, government interventions were important to correct market imperfections and bottlenecks hindering the industrialization process at this time. Our discussion shows that Thailand has relied heavily on foreign investment to promote and nurture local manufacturing activities. Streamlined and coherent rationalized policies were able to shape the behaviour of foreign firms in developing and upgrading local firms. These combined factors transformed Thailand to become an industrial export-oriented country within four decades. As a developing country, Thailand is a success story of policy-driven, trade protectionism during the early stages of industrialization. However, it should be noted that it was essential for a gradual shift in the policy regime towards private-led industrialization and trade liberalization.

Particular to the automotive industry, Thailand has been fortunate that successive governments took a series of progressive steps to liberalize the automotive industry at the right time. We should bear in mind that the Thai government is committed to promoting FDI and uses it as a catalyst to bolster the growth of local supporting industries. Hence, other macroeconomic factors were crucial in attracting

FDI, such as economic stability, readiness of infrastructure, and a pool of skilled labour. This paper found that regional development policies were imperative for the agglomeration of firms. The process was shaped by the regional-based investment incentive scheme and the development of infrastructure, encompassing road networks, seaports and industrial estates, especially those in the ESB areas. In line with RIS literature, devolution was of little consequence in the context of Thailand, because industrial and regional policies have been planned and implemented by the central government (Poapongsakorn and Techakanont 2008). One possible reason that the central government can maintain its significant role may be due to the geographical proximity of manufacturing activities surrounding Bangkok, i.e., the central and the eastern part of Thailand. Basic infrastructure, such as road networks, industrial estates, education facilities and public utilities, can be planned and implemented concomitant with industrialization policies, despite the lack of decentralization.

This study discusses at two levels the dynamic nature of interactive learning, both firm and industry-wide. At the firm level, the case of Toyota's supplier network illustrates the increasing role of a Japanese carmaker as the 'lead firm' in the process of 'knowledge sharing' at both vertical and horizontal levels, in which local firms can benefit from participating as suppliers. However, the benefit from FDI is not instantaneous because MNEs were inactive in transferring technology necessary to upgrade local firms under the trade protected regime. Rationalized policies and a competitive environment (both domestic and international) were necessary to force MNEs to upgrade and develop local firms (Techakanont 2002). A higher technology level has been transferred to Thailand, encompassing product engineering, assembler R&D activities and increasingly active supplier development programs, because of pressure from globalization (Techakanont and Terdudomtham 2004b). This evidence

supports Bhagwati's hypothesis that an open trade policy regime can provide technological benefits to the host economy, as also reported in Kohpaiboon (2005).

Interactive learning at the industry-wide level is rather weak. Local firms have grown with little development of their technological capabilities and their learning has been slow and passive, Mukdapitak (1994). Based on the Innovation Survey in 2001, Thai firms and institutions still have limitations in conducting the research and development necessary to create new technology. Although local firms collaborate with other entities is consistent with an 'open innovation' concept, Thai companies tend to rely on 'incremental' or 'process' innovation. This study observed that local companies normally have a low tendency to cooperate with partners in vertical or horizontal linkages, but a high tendency at the institutional level. Absorptive capacity is one precondition for R&D cooperation and local firms are relatively weak here and generally have no in-house R&D divisions. The degree of localized learning tends to be high if there exists; 1) localized capabilities that underpin and give direction to knowledge creation or 2) benefits of spatial proximity in processes of interactive learning (Malmberg and Maskell 2006). Our analysis revealed that Thailand seems to have weaknesses in the former consideration, 'localized capabilities' or 'absorptive capacity.' This may be an explanation for this observation and policy makers should exercise caution here.

As Asheim and Coenan (2005) remark, a successful regional cluster can run into serious problem because of 'lock-in' tendencies, in which local firms are reliant on process innovations based on tacit or organizational routines, without exploring to create product innovation. Radical or product innovations are necessary for sustainable development. Local firms should be prepared and need to scan across available sources of knowledge to make significant improvement in their existing products (Laursen and

Salter 2006). In doing so, the scientific knowledge base is a vital factor driving technological development and cooperation between indigenous firms and innovation supporting organizations is of particular importance. However, we disagree with one of Chaminade and Vang's (2008a) suggestions that Thailand should regulate the relationship between MNEs and local SMEs, i.e., force MNEs to subcontract to domestic firms. Rather, as world trade has evolved engendering an increasing degree of globalization and trade liberalization, government policies should turn to providing a supportive role, with a primacy focus on ensuring macroeconomic stability, smooth labour relations, human resource development, and maintaining and enhancing technological infrastructure. As findings are bound in the context of a specific country, policy measures suggested here should be considered as illustrative. Future research is needed to bridge our understanding on the dynamic links between clusters and innovation, and localized learning or interactive learning and technological development in indigenous firms. This may allow us to successfully upgrade the economy to a higher level in the global value chain.

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Appendix

Outputs of the Research Project

1) Poapongsakorn, Nipon, and Techakanont, Kriengkrai, (2008) "The Development of Automotive Industry Clusters and Production Network in Thailand," pp. 196-256, in Production Networks and Industrial Clusters. Edited by Kuroiwa Ikuo and Toh Mun Heng, Singapore: ISEAS.
2) Techakanont, K. (2008)."The Evolution of Automotive Clusters and Global Production Network in Thailand". ERTC Discussion Paper No.6, Faculty of Economics, Thammasat University, Bangkok, Thailand. (*downloadable from* http://www.econ.tu.ac.th/?menu=164&lang=th#cnt333)
3) "The Evolution of Automotive Clusters and Global Production Network in Thailand" presented at Korea Economics and Business Association 2008 International Conference, "Knowledge Economy, Regional Development and Free Economic Zone, Daegu-Gyeongbuk Development Institute, Korea, 14-15 November 2008.
4) "Global production network, knowledge sharing, and technology transfer: Evidence from Thailand", ISNIE Annual Conference, Haas School of Business, University of California, Berkeley, June 18-20, 2009. (Abstract only)
5) Techakanont, Kriengkrai. and Charoenporn, Peera. *Evolution of Automotive Clusters and Interactive Learning in Thailand*. Science, Technology & Society (accepted: to be published in volume 16, number 2, 2011)

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