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นโยบายการเงิน การคลัง และวัฏจักรธุรกิจไทย

On monetary and fiscal policy mix over Thailand's business cycles

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บทสรุป

ข้อคิดเห็นที่ปรากฏในบทความนี้เป็นความเห็นของผู้เขียน
ซึ่งไม่จำเป็นต้องสอดคล้องกับความเห็นของธนาคารแห่งประเทศไทย

บทวิจัยนี้ได้ค้นหาเกณฑ์ที่ควรเป็นมาตรฐานใช้วัดความสำเร็จของการดำเนินนโยบายการเงินและการคลังที่เหมาะสมที่สุดในเชิงอรรถประโยชน์ของสังคม (Optimal policy rules) และได้ศึกษาหลักฐานในอดีตว่านโยบายการเงินและการคลังมีเกณฑ์หรือไม่อย่างไร และมีความสอดคล้องต่อเป้าหมายเสถียรภาพเศรษฐกิจหรือไม่ โดยที่เกณฑ์นี้ควรตั้งอยู่ในรูปของการมีเป้าหมายที่ประกาศชัดเจนในการดำเนินนโยบายการเงินและการคลัง สำหรับเป้าหมายที่เหมาะสมที่สุดของทั้งสองนโยบาย คือ การได้มาซึ่งอัตราเงินเฟ้อในระยะสั้นที่ต่ำ และการที่ผลิตภัณฑ์มวลรวมประชาชาติอยู่ใกล้เป้าหมายให้ได้อยู่ตลอด ทั้งนี้ เราได้ใช้คำจำกัดความของนโยบายการคลังที่คลอบคลุมทั้งภาครัฐ นั่นก็คือทั้งรัฐบาลกลาง รัฐบาลท้องถิ่น รัฐวิสาหกิจ และหน่วยงานที่ดำเนินกิจกรรมกึ่งการคลัง (Quasi-fiscal entities) นอกจากนี้ บทวิจัยนี้ยังได้พยายามหาเกณฑ์ที่จะใช้กับเครื่องมือในการดำเนินนโยบาย อันได้แก่ อัตราดอกเบี้ยระยะสั้น และ ดุลงบประมาณภาครัฐแบบระยะปานกลาง (Multi-year public-sector budget balance) เพื่อให้การดำเนินนโยบายทั้งสองสามารถบรรลุเป้าหมายเงินเฟ้อและการเจริญเติบโตทางเศรษฐกิจที่เห็นชอบร่วมกันได้ภายใต้สถานการณ์ต่างๆที่ภาวะเศรษฐกิจอาจเผชิญ การดำเนินนโยบายของทั้งธนาคารกลางและกระทรวงการคลังสามารถส่งผลกระทบต่อทั้งอัตราเงินเฟ้อในระยะสั้นและการขยายตัวของเศรษฐกิจซึ่งเป็นเป้าหมายได้ ดังนั้น ในการตั้งเป้าหมายที่เหมาะสม (Optimal targets) จำเป็นต้องอาศัยความร่วมมือกันของทั้งสองนโยบาย ขณะที่ในทางปฏิบัติการใช้เครื่องมือต่างๆในการดำเนินนโยบายทั้งสองควรมีความเป็นอิสระจากกัน และต้องยึดมั่นต่อเป้าหมายที่ได้ร่วมกันตั้งไว้ โดยที่คำนึงถึงผลของการใช้เครื่องมือในการดำเนินนโยบายของแต่ละฝ่ายที่จะมีต่อเป้าหมายดังกล่าวด้วย

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บทสรุปผู้บริหาร

เศรษฐกิจของประเทศไทยจะเติบโตได้อย่างมีเสถียรภาพในระยะยาวนั้น ขึ้นอยู่กับการขยายตัวของประสิทธิภาพการผลิต ซึ่งการเพิ่มประสิทธิภาพการผลิตนี้ขึ้นอยู่กับความร่วมมือกันของผู้มีบทบาทต่างๆในสังคมไทยด้วย สำหรับผู้ที่เกี่ยวข้องกับการกำหนดและดำเนินนโยบายเศรษฐกิจมหภาคนั้น งานที่สำคัญในปัจจุบัน คือ การบริหารจัดการภาวะเศรษฐกิจในช่วงวัฏจักรขาขึ้นนี้ให้มีเสถียรภาพ เพื่อเอื้อให้ผู้ประกอบการภาคเอกชนสามารถใช้ศักยภาพการผลิตของตนได้อย่างมีประสิทธิภาพสูงสุด ดังนั้น การดำเนินนโยบายทั้งการเงินและการคลังควรเป็นแบบมองไปข้างหน้าเพื่อบ่งชี้และจัดการความเสี่ยงที่อาจจะเกิดขึ้น และเป็นไปโดยสอดคล้องเพื่อดูแลเป้าหมายซึ่งก็คือเสถียรภาพของเศรษฐกิจในระยะต่อไป

ธนาคารกลางและกระทรวงการคลังในฐานะผู้มีบทบาทในการดำเนินนโยบายการเงินและการคลังจะสามารถบรรลุเป้าหมายในการดูแลเสถียรภาพทางเศรษฐกิจอย่างมีประสิทธิผลสูงสุดได้ หาก (1) สามารถดำเนินนโยบายได้อย่างเหมาะสม และ (2) ภาคเอกชนสามารถเข้าใจนโยบายต่างๆ และคาดการณ์ทิศทางการดำเนินนโยบายต่อไปในอนาคตได้ถูกต้องเพื่อที่จะสามารถตอบสนองต่อการดำเนินนโยบายเหล่านั้นได้ในรูปแบบที่ภาครัฐเองคาดเอาไว้ การมีเกณฑ์ที่เป็นระบบในการดำเนินนโยบาย (Rules: systematic conduct of policies) ที่เหมาะสมและโปร่งใสจะช่วยเพิ่มความชัดเจนของวัตถุประสงค์ของนโยบาย ซึ่งจะช่วยทำให้การสื่อสารนโยบายและการบรรลุเป้าหมายของตัวนโยบายเองเป็นไปอย่างมีประสิทธิผลมากขึ้น

บทวิจัยนี้จึงต้องการค้นหาเกณฑ์ที่เหมาะสมที่สุดของการดำเนินนโยบายการเงินและการคลัง โดยเริ่มจากการทำความเข้าใจบทเรียนในอดีต ต่อเนื่องไปสู่อนาคต ทั้งนี้ จากการที่เศรษฐกิจไทยเป็นเศรษฐกิจที่เติบโตอย่างรวดเร็ว และค่อนข้างมีเสถียรภาพในอดีตเมื่อเทียบกับประเทศกำลังพัฒนาอื่นๆ เราจึงต้องการค้นหาคำตอบว่าการดำเนินนโยบายการคลังและการเงินของไทยในอดีตมีเกณฑ์การดำเนินนโยบาย (Rules) อะไรบ้างที่สำคัญ ดังนั้นจึงได้ย้อนกลับไปพิจารณาและศึกษาการดำเนินนโยบายเศรษฐกิจมหภาคของไทยระหว่างช่วงปี 1970-2003 ซึ่งจากการศึกษาข้อมูลในช่วงดังกล่าว รวมทั้งวิเคราะห์แนวการดำเนินนโยบายและผลที่เกิดขึ้น พบว่าในช่วงดังกล่าวทั้งนโยบายการเงินและการคลังมีเกณฑ์การดำเนินนโยบายและมีเป้าหมายที่ชัดเจน (explicit targets) โดยนโยบายการเงินมีเกณฑ์การดำเนินนโยบายที่สำคัญคือการกำหนดเป้าหมายอัตราแลกเปลี่ยน (Exchange rate targeting) ในช่วงปี 1970-1997 ในขณะที่รัฐบาลตั้งเป้าหมายการดำเนินนโยบายเป็นรายปี และตั้งแต่ปี 2000 เป็นต้นมาก็ได้ใช้กรอบนโยบายการกำหนดเป้าหมายเงินเฟ้อ (Inflation targeting)

ภายใต้กรอบอัตราแลกเปลี่ยนคงที่ บทบาทของนโยบายการเงินมีจำกัด นโยบายการคลังจึงมีบทบาทที่สำคัญในการ counter cyclical บทวิจัยนี้พบว่าก่อนหน้าที่จะมีการปฏิรูปการคลังในช่วง

กลางทศวรรษที่ 80 นั้น การดำเนินนโยบายการคลังมีลักษณะ pro-cyclical และไม่สอดคล้องกับนโยบายการเงินที่มุ่งเน้นรักษาอัตราแลกเปลี่ยนให้คงที่ หลังการปฏิรูปการคลัง การจัดเก็บรายได้ของรัฐบาลเพิ่มสูงขึ้นอย่างเห็นได้ชัด โดยที่ภาษีทางตรงเก็บได้เพิ่มขึ้นค่อนข้างมาก นอกจากนี้ บทบาทการเป็น Automatic stabilizer ของภาษีทางตรงเหล่านี้จึงเพิ่มขึ้นเป็นลำดับ เพราะฉะนั้น กระทรวงการคลังจึงสามารถดำเนินนโยบายได้อย่างมีประสิทธิผลมากขึ้น ช่วงต้นทศวรรษที่ 1990 การเติบโตของสินเชื่อประกอบกับการเปิดเสรีทางการเงิน ภายใต้นโยบายอัตราแลกเปลี่ยนคงที่ พร้อมกับภาวะการเงินที่ไม่ได้เปลี่ยนแปลงมากนัก (โดยวัดจากดัชนีภาวะการเงิน หรือ Monetary condition index) แสดงให้เห็นว่านโยบายการเงินไม่ได้ตอบสนองต่อวัฏจักรเศรษฐกิจขาขึ้นอย่างที่ควรเป็น

นโยบายการคลังในช่วงปี 1987-1997 เอื้อต่อการรักษาระดับอัตราแลกเปลี่ยนซึ่งเน้นการเจริญเติบโตของเศรษฐกิจ ผ่านการไหลเข้าของเงินทุนเคลื่อนย้าย ในขณะที่ทั้งนโยบายการเงินและการคลัง
มีบทบาทใน counter cyclical น้อยลงเรื่อยๆ ซึ่งในความเป็นจริงแล้ว ณ ขณะนั้น ควรที่นโยบายการคลังภายใต้อัตราแลกเปลี่ยนคงที่ จะ counter cyclical ได้มากกว่านี้ จากการศึกษาพบว่าเกณฑ์การดำเนินนโยบายการคลังได้แก่การตั้งเป้าการเกินดุลการคลังเบื้อต้น ซึ่งกระทรวงการคลังเริ่ม commit มากขึ้นแต่ความหมายของดุลการคลังในขณะนั้นไม่ได้ครอบคลุมไปถึง public sector ทั้งหมด และยังไม่ได้เห็นข้อดีของการวางนโยบายแบบมองไปข้างหน้าเท่าที่ควร ในขณะนั้นไม่ปรากฏหลักฐานว่าเงินเฟ้อเป็นเป้าหมายสำคัญโดยตรงแต่อย่างใด

นอกจากนี้ บทวิจัยนี้ยังได้ค้นหาเกณฑ์สำหรับการดำเนินนโยบายการเงินและการคลังที่เหมาะสมที่สุดในเชิงอรรถประโยชน์ของสังคม (Optimal welfare-maximizing policy rules) และเกณฑ์ดังกล่าวนี้ตั้งอยู่ในรูปของการมีเป้าหมายที่ประกาศชัดเจนในการดำเนินนโยบายการเงินและการคลัง สำหรับเป้าหมายที่เหมาะสมที่สุดของทั้งสองนโยบาย คือ การได้มาซึ่งอัตราเงินเฟ้อในระยะสั้นที่ต่ำ และการที่ผลิตภัณฑ์มวลรวมประชาชาติอยู่ใกล้ศักยภาพสูงสุดให้ได้อยู่ตลอด ทั้งนี้ เราได้ใช้คำจำกัดความของนโยบายการคลังที่คลอบคลุมทั้งภาครัฐ นั่นก็คือทั้งรัฐบาลกลาง รัฐบาลท้องถิ่น รัฐวิสาหกิจ และหน่วยงานที่ดำเนินกิจกรรมกึ่งการคลัง (quasi-fiscal entities)

นอกจากนี้ บทวิจัยนี้ยังได้พยายามหาเกณฑ์ที่จะใช้กับเครื่องมือในการดำเนินนโยบาย ได้แก่ อัตราดอกเบี้ยระยะสั้น และ ดุลงบประมาณภาครัฐแบบระยะปานกลาง (Multi-year public sector budget balance) เพื่อให้การดำเนินนโยบายทั้งสองสามารถบรรลุเป้าหมายเงินเฟ้อและการเติบโตทางเศรษฐกิจที่เห็นชอบร่วมกันได้ภายใต้สถานการณ์ต่างๆที่ภาวะเศรษฐกิจอาจเผชิญ

การดำเนินนโยบายของทั้งธนาคารกลางและกระทรวงการคลังสามารถส่งผลกระทบต่อทั้งอัตราเงินเฟ้อในระยะสั้นและการขยายตัวของเศรษฐกิจซึ่งเป็นเป้าหมายได้ ดังนั้น ในการตั้งเป้าหมายที่เหมาะสม (Optimal targets) จำเป็นต้องอาศัยความร่วมมือกันของทั้งสองนโยบาย ขณะที่ในทางปฏิบัติ การใช้เครื่องมือต่าง ๆในการดำเนินนโยบายทั้งสองควรมีความเป็นอิสระจากกัน และต้องยึดมั่นต่อเป้าหมายที่ได้ร่วมกันตั้งไว้ โดยที่คำนึงถึงผลของการใช้เครื่องมือในการดำเนินนโยบายของแต่ละฝ่ายที่จะมีต่อเป้าหมายดังกล่าวด้วย

เมื่อเศรษฐกิจต้องเผชิญกับ shock ต่าง ๆ อัตราดอกเบี้ยแท้จริงจะถูกกระทบ รวมไปถึง output gap (ส่วนต่างระหว่าง GDP และเป้าหมายของ GDP) และเงินเฟ้อในอนาคตด้วย นโยบายการเงินโดยการปรับอัตราดอกเบี้ย (nominal interest rate) จะต้องตอบสนองต่อปัจจัยเหล่านี้ รวมทั้งช่วยเสริมในกรณีที่นโยบายการคลังไม่สามารถตอบสนองต่อ shock ได้อย่างเต็มที่ การรักษาเสถียรภาพได้อย่างสมบูรณ์นั้น จำเป็นอย่างยิ่งที่นโยบายการคลังจะต้องดำเนินนโยบายแบบมองไปข้างหน้าเพื่อรับผลกระทบของ shock ได้อย่างเต็มที่ ในกรณีที่รัฐบาลไม่ประสบปัญหาจากข้อจำกัดในการกู้ยืมในประเทศ รัฐบาลควรปรับระดับการกู้ยืมและดุลการคลังให้เหมาะสมเพื่อที่จะจัดการกับความต้องการทางการคลังที่ได้คาดการณ์เอาไว้ หากรัฐบาลประสบปัญหาจากข้อจำกัดในการกู้ยืม นโยบายการเงินจะต้องตอบสนองมากขึ้นเพื่อช่วยเหลืออีกแรง ตราบใดที่รัฐบาลและธนาคารกลาง commit ต่อเป้าหมายที่ได้ตกลงไว้ล่วงหน้าแล้วนั้น ควรมีการแบ่งภาระหน้าที่ในการดำเนินนโยบาย โดยเฉพาะเมื่อนโยบายใดนโยบายหนึ่งมีข้อจำกัด

เพื่อให้การสื่อสารนโยบายภาครัฐเป็นไปอย่างมีประสิทธิผลธนาคารกลางควรประกาศ และ commit ต่อเป้าหมายในรูปแบบของ “Flexible inflation target” สำหรับ Interest rate reaction function นั้น สามารถใช้ในการประกอบการดำเนินนโยบายโดยไม่ต้องประกาศทิศทางของนโยบายไว้ล่วงหน้าก็ได้ ทั้งนี้ หากธนาคารกลางสามารถทำให้ภาคเอกชนเชื่อถือใน commitment ต่อเป้าหมายได้แล้วไม่มีความจำเป็นที่จะต้องประกาศแนวโน้มอัตราดอกเบี้ยอย่างเป็นทางการ ในกรณีนี้ ความสำเร็จในอดีตที่ผ่านมาจะมีความสำคัญอย่างยิ่ง รัฐบาลสามารถเลือก commit ต่อดุลการคลังเบื้องต้นที่ประกาศไว้ล่วงหน้า บทความนี้เสนอแนะให้รัฐบาลประกาศและ commit ต่อทิศทางของดุลการคลังในรูปแบบของ multi-year basis เนื่องจากดุลการคลังเป็นเครื่องมือที่ภาคเอกชนคุ้นเคยอยู่แล้ว

It is a widely accepted proposition in growth economics that monetary and fiscal policy cannot lift the long-term growth path of an economy.[1] The goals of these policies are thus limited to achieving and maintaining economic stability. Having and committing to "appropriate" macroeconomic policy rules work to the advantage of the economy toward that end.

This paper explores how optimal targeting rules in the form of inflation and output gaps can work in Thailand going forward. We begin first by exploring the period under exchange rate targeting during 1970-1997 to discern whether Thailand's monetary and fiscal policies follow well-defined rules, and find that policy rules are not foreign to Thailand. We obtain specific targeting rules in the spirit of Benigno and Woodford (2003), target-consistent interest rate reaction function for the central bank and corresponding tax and surplus functions for the fiscal authority, calibrate a quarterly optimization model to Thailand's growth facts, and finally explore scenarios of disturbances that the economy may face. We discuss implications of macroeconomic policy coordination, policy commitment, independence of the central bank, and how to enhance the effectiveness of monetary policy under the current inflation targeting framework as practiced by the Bank of Thailand. In the nutshell, monetary and fiscal authorities can affect near-term inflation and output, and so optimal target setting requires coordination. In practice, we find that instruments such as interest rate and nominal public-sector budget balance should be set independently to ensure *commitment* to the targets, taking into account the consequences on the targets of the other party's instruments.

For the purpose of this study, we define policy rules comprehensively as systematic conduct of macroeconomic policy, which consists of monetary and fiscal policy.[2] We also recognize in this paper that fiscal policy has consequences for inflation determination and that monetary policy action has effects on the government budget, in other words, that monetary policy has fiscal consequences. We take policy target criterion to mean a benchmark for policy success. Rules may be specified in terms of a target criterion for each authority. In this case, in every period, each authority commits itself to using its policy instruments, (be it short-term interest rates, the nominal exchange rate, taxes, transfers, or nominal debt,) as necessary so key economic variables can be projected in a way that is consistent with its target criterion.

Inflation targeting as practiced by the Bank of Thailand is an example of a monetary policy rule. With the commitment that the quarterly-averaged annual inflation rate be maintained between 0 and 3.5 per cent, the Bank of Thailand follows a rule by which it may in theory opt to use the 14-day repurchase rate or the nominal exchange rate however necessary to achieve its inflation target. In the course of conducting policy, the central bank makes an eight-quarter-ahead projection of inflation and adjusts its policy instrument, the 14-day repurchase rate, so as to ensure that the projected inflation outcome is within the pre-announced target range. Equivalently, the fiscal authority may want to use the nominal

[1] For literature review and a fresh look at the proposition, see Ahuja and Muenjak (2002), among others.

[2] The flexible exchange rate policy is subsumed under an independent monetary policy, since for it to be workable on average the exchange rate policy must be largely consistent with interest rate policy. Hence, we may not discuss the exchange rate policy explicitly, focusing solely on monetary policy as characterized by movements in the short-term policy interest rate. The optimal targeting rules derived and used in this paper are *not* instrument-specific, however; that is, the central bank may choose to achieve its target using either a short-term interest rate or the nominal exchange rate as its instrument.

primary (public sector) budget balance as an instrument to achieve a certain explicit, widely understood goal.

In this paper, the relevant actor on the monetary side is the central bank and that on the fiscal side is the overall government. That is, in the case of Thailand, the latter includes central government, local government, (non financial) state enterprises, and any entity that discharges policy on behalf of the general government (quasi-fiscal policies), whose balance sheets, it can reasonably be assumed, may be connected to or alleviated by the general government when under stress at some date in the future. In short and without loss of generality, overall government, in normal times, is every government-related entity other than the private sector -- households, private firms, non-profit organizations and financial intermediaries.[3]

The fundamental idea of having and committing to appropriate policy rules is based on the premise that the central bank and the fiscal authority can most effectively achieve their stabilization goals if (1) the authorities act appropriately and (2) the private sector (or its relevant subset) widely understands those actions, which in turn allow them to act or respond in a certain predictable way. This is the key substance of macroeconomic expectations management. Subsumed under this idea is the issue of the authorities' communication with the private sector. Having well-defined and widely understood rules that may be expressed in the form of policy targets or target-consistent policy instruments can enhance the authorities' clarity of purpose, which helps buttress the effectiveness of policy communication and ultimately of policy itself. That said, our goal is to find optimal targeting criteria for Thai monetary and fiscal authorities, and demonstrate their effectiveness in achieving short-run stabilization goals into the future.

The advantage of rules over discretion can be established in the sense of effective expectations management, and we can now discuss the kind of macroeconomic policy rules that is appropriate. To be sure, an appropriate rule should take advantage of the private sector's anticipation of policy at earlier dates. That is, it is desirable that, at an earlier time, economic agents be able to count on the fact that the authorities will subsequently follow up on a certain policy in a predictable fashion. This way, to a large extent, the private sector can predict policy action at an appropriate time and the authorities can predict how the private sector will respond to anticipated policy action.[4] In short, the issue is that of taking advantage of private expectations to further the stabilization goals by shaping them *at earlier dates* to achieve a desirable outcome today and in the future, and having an explicit policy target works toward that end.

If we accept the premise that a significant part of the authorities' task is to manage expectations, and that the authorities can take advantage of having rules for policy conduct through letting the private sector anticipate policy action correctly on average at earlier dates, then it is quite logical that recent *past* (and not only future) conditions should be taken into account in setting current policy. This is also consistent with the suggestion of a certain

[3] This notion of government is used in the model, to be outlined below, and in matching model's parameters to the data.

[4] Policy makers should not dismiss the effects of private-sector expectations at earlier dates of a different *current* policy action from the one that policy makers may judge to be best today.

degree of inertia or "gradualism" in policymaking in normal stabilization.[5] Gradualism here is used in the sense that transcends the oft-used analogy of an economy as a giant oil tanker, which needs to change course gradually because of its displacement, speed, given current oceanic and weather conditions. The sense of "gradualism" that we also wish to emphasize is that, unlike the tanker, a multitude of households and firms that comprise the economy have their own sets of expectations regarding future paths of policy instruments, *inter alia*. This should enable policymakers who understand private sector expectations to manage them for the purpose of enhancing policy effectiveness.

It is our main thesis that for policy action to lead to a welfare maximizing or optimal outcome, the goals or target criteria of monetary and fiscal authorities must at least be consistent with each other. That is, as a necessary condition, the monetary and fiscal authorities should come to an agreement with regard to the specifics of what constitutes the target criteria. This idea comes from the observation that, in the *short run*, price stability may not be in the sole custody of the central bank. That is, for example, the short-term effects of higher tax rate on firms' real marginal costs and therefore on the aggregate supply and inflation are tangible. Since the effects of fiscal policy on inflation are tangible, it follows that both monetary and fiscal policy can be used to stabilize inflation, which is a key measure of economic stability.

We take seriously and rely heavily on the results of Benigno and Woodford (2003) that in an economy that is buffeted by various economic disturbances and where prices are even slightly sticky, the target criteria for the central bank and the fiscal authority that wish to maximize welfare of its citizens specifically consist of a "flexible inflation target" (defined as low and stable near-term inflation and minimum near-term "output gap") and a low and stable expected (future) inflation.[6] If inflation can be precisely measured, "low and stable" here means zero. But, inflation measurement is generally biased upward; hence, an optimal inflation target may be slightly positive.

These optimal target criteria are not only consistent with the desired inflation and output outcome, but they also determine the most desirable rational-expectations outcome, ruling out equally possible, but undesirable ones, and bring about optimal responses to various characters of economic disturbances.[7] Because the optimal targeting criteria expressed in the form of inflation and changes in the "output gap" (correctly defined) are simple, they are useful for policy communication with the public.

The target criteria alone, however, do not specify the means with which the authorities can achieve the desired outcome. We therefore extend previous results to obtain corresponding instrument rules for the monetary and fiscal authorities in the form of an interest-rate reaction function and the nominal primary public sector budget balance path that will ensure that the target criteria are achieved and welfare maximized. These instrument reaction functions are partly forward looking, incorporating anticipation of economic

[5] Note that we are limiting ourselves to normal macroeconomic conditions that generally prevail in most developed and newly industrialized economies; that is we abstract away for now from the extreme cases in which the private sector may have perverse self-fulfilling expectations, be it inflationary or deflationary.

[6] Precisely measured, "low and stable" here means zero. But, inflation measurement is generally biased upward; hence, an optimal inflation target may be slightly positive.

[7] This is one of the highlights of Benigno and Woodford (2003), which follows in the tradition of Giannoni and Woodford (2002) and Woodford (2003, Chapter 7).

disturbances, their effects on future "potential" output and of future inflation.[8] The path of nominal budget balance in this case also corresponds to those of fiscal policy instruments, namely the effective tax rate of the public sector and the level of nominal public debt, given the path of public expenditure. These "expectations-based" optimal policy reaction functions are useful for policy makers in decisions regarding the paths (size and timing) of the instruments.

For the sake of effective policy communication to the private sector, we recommend that the central bank announce publicly its commitment to its target and keep its (target-consistent) instrument's reaction function for use in internal policy debate or guidance. There is no need to announce the interest rate path formally if the central bank can convince the public of its commitment to the near-term targets. In this matter, track record is paramount. The government, on the other hand, may choose to commit to a pre-announced instrument path, in particular, the nominal primary public sector budget balance (henceforth, for the sake of brevity, the primary budget balance). We recommend that the government announce and commit to a path for its instrument in the near term because this is what the government normally does announce (albeit only for central government budget balance and on one-fiscal-year basis in the case of Thailand) and the public is already familiar with its surplus or deficit target.

We advocate that target criteria be determined jointly while instruments be set independently to ensure *commitment* to the targets, taking into account the consequences on the targets of the other party's instruments. Moreover, the optimal target criteria should be used as a guide for policy coordination. That is, in recognition of short-term structural reality in the Thai economy, namely the fact that the Thai government's major sources of revenue are distortionary taxes (as opposed to lump-sum or seigniorage taxes), much like the case in any advanced economy, and that prices in Thailand display a degree of stickiness[9] (as opposed to fully flexible prices), we advocate target dependence and instrumental independence in monetary and fiscal policy coordination.

The rest of the paper is outlined as follows: Section 1 explores past practices during 1970-2003 of fiscal and monetary policy makers in Thailand to discern whether they follow certain well-defined rules, and whether those rules are consistent with each other or with the stabilizations goals to be defined. In section 2, we describe the essential highlights of the environment of the model economy used by Benigno and Woodford (2003), outline the policy problem facing monetary and fiscal authorities. Then, we solve and characterize the approximate linear-quadratic policy problem in section 3, demonstrating general results for optimal target criteria along the line of Benigno and woodford (2003). Subsequently, we give an optimal target-consistent interest rate reaction function for the central bank and a surplus function for the fiscal authority. In section 4, we calibrate the model to fit Thailand's stylized facts. We then perform a computational experiment on a likely set of scenarios of disturbances and discuss optimal responses to them. Section 5 concludes and outlines briefly direction for future research.

[8] It is important to note that, in equilibrium, the central bank's interest rate reaction function will be effectively independent of fiscal variables, provided that the government's borrowing constraint does not bind. This point is expanded further below.

[9] According to our calculation reported in the data appendix based on changes in the consumer price basket, as surveyed by Thailand's Ministry of Commerce both during the few years before the financial crisis of 1997 and from January 2002-May 2004.

1. Fiscal and monetary policy formation during 1970-2003

Thailand's real GDP has experienced the fastest growth in the world during 1970-2003. We focus in this section on discerning whether monetary and fiscal policy conduct during that period follows certain well-defined rules. The period 1970-2003 is picked because of the lack of reliable detailed data prior to 1970. Moreover, we wish to look for evidence pointing to coordination or consistency between fiscal and monetary policy vis-à-vis the stabilization goals discussed earlier..

This section starts by discussing Thailand's business cycles and inflation paths over 1970-2003. It then proceeds to describe observed fiscal and monetary policy rules, and explain the tools used to measure fiscal and monetary policies. These tools are later used to analyse fiscal and monetary policy mix and its impacts on business cycles.

The findings show that there have been rules governing the conduct of fiscal and monetary policies during 1970-2003. These rules allow the authorities to respond to changes in domestic and international economic conditions with explicit targets. Prior to 1987, there were times when fiscal and monetary policies inconsistent. Macroeconomic policy coordination improved after 1987 as a result of fiscal reforms starting in the mid-1980s. Going forward, how fiscal and monetary policies should coordinate if our ultimate goals are to achieve economic growth with price stability over the long run remains a key challenge.

For this study, the government sector data are all compiled according to the Government Financial Statistics (GFS) 1986 methodology.[10] We use the GFS (with available coverage of the central government only) dataset, instead of the Bank of Thailand's "cash-balance-basis" data, because the methodology is widely used across countries, and therefore enables future cross-country comparison. Moreover, the GFS methodology consolidates the accounts of all parts of the government, thus enable us to avoid double-counting. The GFS dataset, unlike the cash balance basis, also allows a more comprehensive analysis, as, for example, it treats often large sums of interest payments on international loans and external funds as parts of an annual fiscal budget.

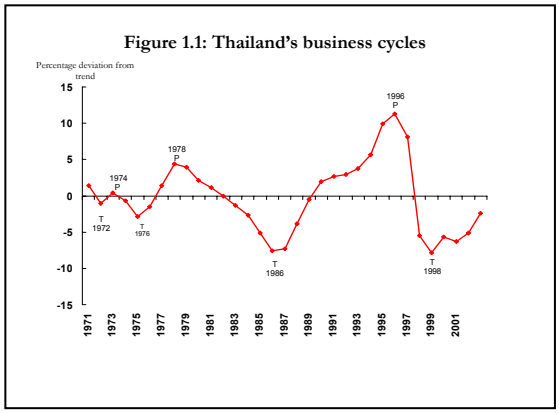
First, we give a brief set of historical facts regarding the business cycle and inflation in Thailand. We define and measure the business cycle as percentage deviation from long-term real GDP trend, which is calculated using the Hodrick-Prescott filter with the standard smoothing factor of 1600.[11] Figure 1.1 shows that, during the period of interest, the Thai economy has experienced three complete cycles (measured from peak to peak), 1969-1973, 1973-1978, 1978-1996, and is now in the process of recovering from the trough observed in 1999. Over time, it can be seen that Thailand's business cycles have lasted longer and become more volatile.

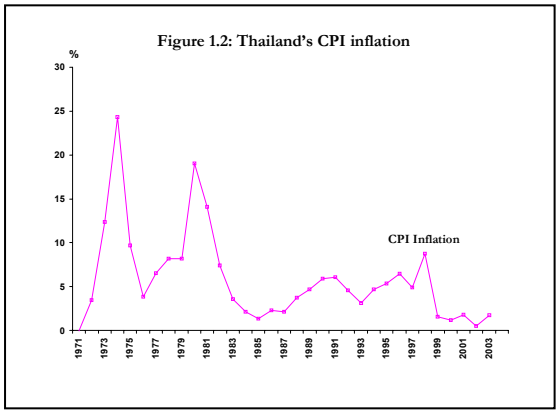
From 1970 to the early 1980s, inflation has been relatively high and volatile. This period can be associated with various world economic events with known inflationary

[10] The data used in this paper follows the 1986 GFS manual because they available for a longer period, although those that follow the GFS 2001 methodology also exist. Because the two datasets produce reasonably similar time-series, our result should be insensitive to the choice of datasets.

[11] Since the HP filter is sensitive at the end of the time series, we assume a 6-per-cent trend growth rate for 2004 and 2005.

consequences, namely the oil price shocks of 1973 and 1979,[12] world prices of agricultural products, and import prices. After this period, shown in Figure 1.2, inflation has been lower and more stable, particularly post-2000.



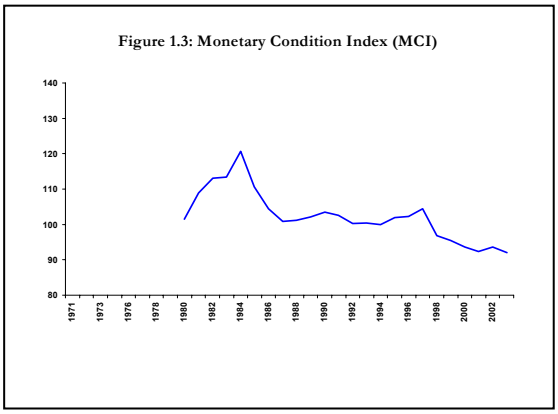


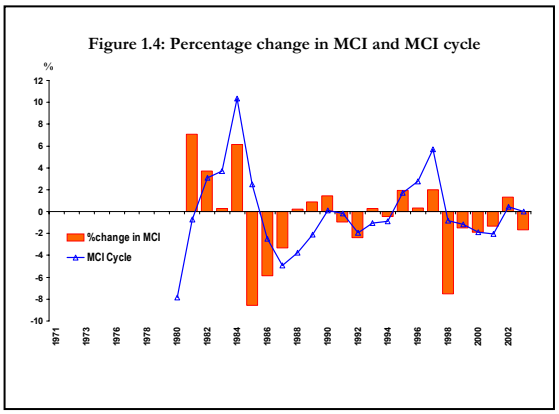
1.1 Representation of monetary and fiscal policy action

Monetary policy is represented by a linear combination of 2 policy instruments in the form of a monetary condition index (MCI), which is calculated as suggested by Freedman (1996). The MCI measures monetary conditions at a particular date compared to that in a chosen base year. It is a weighted sum of a percentage point change in domestic interest rate and a percentage change in an exchange rate compared to their corresponding values in a chosen base year, the general form of which can be expressed as:

$$MCI\ (P_t) = [\ 0.69\ (i_t - i_{1994}) + 0.31\ (REER_t - REER_{1994})\ ] + 100,$$

where *i* is the real interest rate, and *e* the real exchange rate. The higher MCI is the tightening condition monetary policy is in that particular year. While MCI level captures monetary conditions in a particular period, an annual percentage change in MCI should serve as a representation of direction of past monetary policy (Figure 1.3).





In the process of calculating MCI for Thailand for our analytical purpose, we have to make decisions as to which short-term interest rate to use during the fixed exchange rate period, as none of them was explicitly made policy instrument, and regarding weights of

[12] Inflation peaked at 24.3 and 19.0 per cent in 1974 and 1980, respectively, after the first and second oil shocks.

interest rates and exchange rates, and the base year. The interest rate and the exchange rate are proxied by the real inter-bank overnight (IB) rate and the real effective exchange rate (REER) respectively.[13] The weights are derived from the Bank of Thailand's macroeconometric model[14] as the impact on the price level from one percentage point change in real interest rate and one percentage change in real effective exchange rate. The estimation gives the size of interest rate weight of roughly twice that of the exchange rate weight.[15] Finally, we choose 1994 as a base year simply to make it consistent with that of the real effective exchange rate.

In order to give a more comprehensive picture, credit growth is used as a complementary representation of change in monetary policy condition, especially under the fixed exchange rate environment and a structural change due to financial liberalization during the early 1990s. Thailand's real credit growth rate and changes in MCI are highly correlated (at 0.77) during 1980-1997.[16]

To study the conduct of fiscal policy, it is necessary to decompose the total primary budget balance into 2 components, namely the structural budget balance (SBB) and the cyclical budget balance (CBB). Here we follow the decomposition methodology outlined in Hagemann (1999). While the SBB intends to measure the size of the fiscal budget balance that results from the discretion of the government and structural changes in the economy, the CBB measures the size of the fiscal budget balance that are influenced by the business cycles. For example, tax revenue tends to increase, improving the budget balance, during a boom through no conscious effort or decision by the fiscal authority.

Because our focus is on fiscal policy action, we need the SBB, which we obtain as the residual. The CBB should be close to zero when output level is approximately equal to its long-term trend, and positive (negative) when output is above (below) trend, defined here as the HP trend. The SBB can then be found by subtracting the CBB from the actual budget balance; here we consider the primary budget balance of the public sector.

Examining the SBB within sub-periods, in which we do not observe significant effects on the primary balance that results from structural changes in the economy, helps reduce chances of attributing structural changes to discretion of the fiscal authority. More careful interpretation of the SBB is needed particularly during transition periods.[17] The real primary SBB and CBB and the business cycle over 1970-2003 are captured in Figure 1.5.

[13] The choice of an interest rate proxy is unlikely to affect the results, as the short-term interest rates such as, the 14-day repurchase rate (RP14), the minimum lending rate (MLR) and the 3-month deposit rate are all very highly correlated with the IB rate (the correlation coefficients are in the range of 0.85-0.99). The IB is preferable as its time series is longer.

[14] See Bank of Thailand's Inflation Report for the description of BOTMM.

[15] While the precise weights depend the model on which the impulse is performed, we vary the weights from 3:1 to 1:1 and find no significant change in monetary policy representation.

[16] The correlation coefficient declines to 0.66, which is still relatively high, if the post-1997 period is included.

[17] This paper treats the Thai government's central funds as part of the SBB because the government has discretion over its use, although the funds are formally declared to be business cycle related government expenditures.

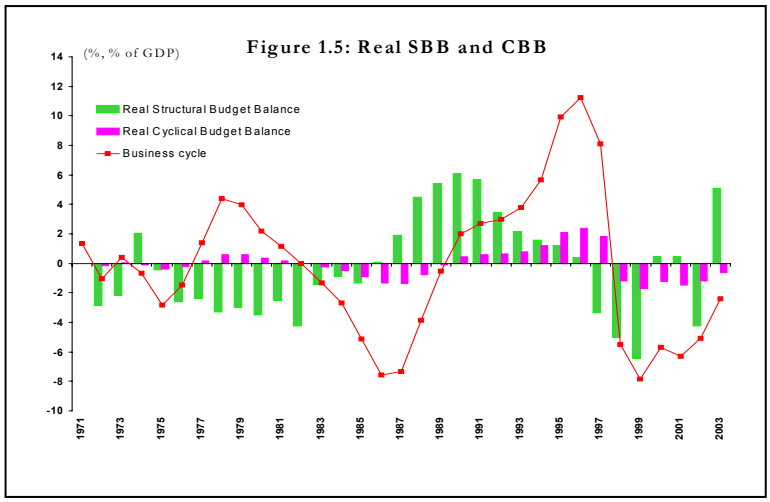


Figure 1.5: Real SBB and CBB

1.2 Fiscal and monetary policy mix over past business cycles

This section analyses the consistency between fiscal and monetary policies over 1970-2003 with regard to the business cycles using the above tools. We do not aim to measure the quantitative effects each policy has on the business cycle or inflation; for that, we need a model as a measuring device. The tools are used to represent policy direction at different stages of the business cycles in a qualitative manner only.

In search of rules, we divide the period of studies into 3 sub-periods, based on data observation, policy announcements and reforms. The three sub-periods are 1970-1986, 1987-1997 and 1998-2003.

Before 1987: During this period, monetary policy follows an explicit rule of targeting the nominal exchange rate. Interest rate management was therefore aimed at keeping the baht steady against the US dollar. In the early 1980s, with fluctuating world interest rates, stress on the balance of payments (especially with net capital outflow), and the speculative attack on the Thai Baht, domestic interest rates had been made to rise. Despite a devaluation of the baht in 1981, MCI increased by 17 per cent during 1980-1984 as a result of rising domestic interest rates. Only after the 14.7-per-cent devaluation in 1984, following drains on the foreign exchange reserves, did monetary policy become more relaxed.[18]

Fiscal policy, as represented by the SBB in this period was quite strongly pro-cyclical with real GDP, in this case falling as GDP rose above its long-term trend and rising as GDP undershot its long-term trend. The contemporaneous correlation coefficient during the period was –0.54. In particular, during 1976-1983, the SBB was in deficit by about 3-5 per cent of GDP, while GDP was consistently above trend. Likewise, the economic recession during 1983-1986 was accompanied by positive structural balance.

The pro-cyclicality of the discretionary fiscal policy was due to several reasons. Large fiscal slack, owing to fairly inefficient tax collection, and the fact that large portion of government expenditures were carry-over (the fiscal year) expenditures certainly play a role. Making adjustments in government spending to suit the stages of the business cycles was

[18] MCI shows sign of mild contemporaneous counter-cyclicality, and lagged the business cycle by roughly 1 year (tightened condition after real GDP rose above trend by roughly 1 year).

made more difficult because of the poor expenditure disbursement rate.[19] In short, the pre-reform tax and expenditure structure all contributed to the near lack of control of the fiscal authority on the fiscal variables in a timely manner; thereby disallowing the fiscal authority to act effectively in a counter-cyclical manner, as economic theory would suggest.

The need to resolve the fiscal stress that arose mainly from debt servicing, the stock of which rose sharply post-1983 on top of previous accumulated deficits, forced the government to make up for revenue shortfall by raising the effective tax rates during an economic slowdown and reduced tax rates during an economic expansion because the tax revenue had met the target. Heavy reliance of government revenue on trade-related transactions during this period points to the fact that direct taxes, important automatic stabilizers, played a limited role. In fact, during 1970-1986, revenue from personal and corporate income tax (PIT and CIT) accounted for only 8.4 and 9.3 per cent of total tax revenues (1.2 and 1.3 per cent of fiscal-year GDP, respectively). On the other hand, 72.8 per cent of total tax revenue came from indirect taxes (business tax, excise, and tax on international trade).

Thus we observe that despite the fact that fiscal policy is the only leg left to counter the GDP cycle under a fixed exchange rate regime, it chose to be pro-cyclical and inconsistent with the exchange rate target before the late 1980s. Moreover, Thai fiscal authority varied the tax rates in order to respond to fiscal stress during the period (we shall come back to this in the model and analysis in the next sections).

To deal with these shortcomings, the Thai government started a serious series of tax and expenditure reform in 1984.[20]

During 1987-1997: The result of the reform was palpable, with fiscal balance switching from chronic deficit into surplus. The success was in part due to higher-than-estimated government revenue. Total government revenue as a percentage of GDP expanded from 14.1 before 1987 to 18.4 during 1987-1996. Fiscal and monetary policy coordination improved significantly and became less pro-cyclical after 1987 as a result of the fiscal reform beginning in 1984. Monetary policy during this period was more accommodative after a significant devaluation in 1984, relieving the pressure on the budget and thereby allowing for fiscal consolidation.

After the reform, revenue rose progressively as a percent of GDP, with direct taxes rising more sharply. That is, the role of automatic stabiliser was enhanced as importance of CIT rose manifold and PIT was on a secularly rising trend. The role of the automatic stabilizer seemed to have increased as the average buoyancy rate for CIT rose from 1.38

[19] The size of government expenditure in GDP was not considerably high. Not only is the amount of spending constrained by lower-than-expected government revenue, the speed and quality of government disbursement were quite poor. Moreover, a large part of expenditures was connected to "current" items such as wages and salaries, rather than productive "capital" programs.

[20] The reform can be summarized thus: There was a series of expenditure cuts starting in 1985-1986, contributing to a significant reduction in the size of total government expenditures as a percentage of GDP from over 20 in 1985 to 15.8 in 1988. Maximum budget growth rate was also set to restrain expenditure. On the revenue side, the 1984 tax reform included changes in PIT's calculation method, an introduction of advanced CIT payment and tax amnesty to widen the tax base, an imposition of withholding tax on interest income, an increase in indirect tax rates on luxurious goods, liquors and cigarettes as well as reforming of tax administration to improve tax collection capability. In effect, it was a wide-ranging reform. On the borrowing side, the government also reduced the ceiling of external borrowing. The external debt committee was also established to coordinating various government agencies and to monitoring the size of external loans.

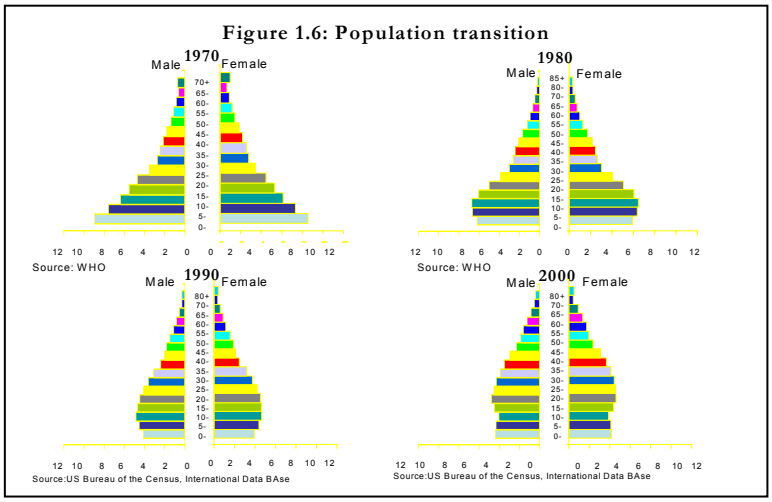
before reform to 1.75 afterward (until 1997) and therefore the size of the CBB changed accordingly from deficit of 1.38 per cent of GDP in 1987 to a surplus of 2.36 per cent of GDP in 1997.

The 1984 tax reform raised the proportion of direct taxes in total tax revenue from 17.7 per cent during 1970-1986 to 25.6 per cent during 1987-1996 (and to 29.3 per cent after 1997). In particular, the proportions of PIT and CIT in real GDP increased from 1.2 and 1.3 per cent before 1987 to 1.8 and 2.9 per cent during 1987-1997, respectively. This phenomenon is consistent with the progressivity of the tax rates and a more unequal income distribution. Indeed, income distribution in Thailand, as measured by income shares by income quintile and the Gini coefficient, deteriorated progressively since the end of the Vietnam War in 1975, according to the Deininger-Squire data set as reported in Table A.1 in the appendix.

Information in Table A.1 helps confirm that in addition to the 1984 fiscal reform, changes in Thailand's economic and social conditions have also contributed toward an improvement in the budget balance. First, income distribution has been more uneven. Since 1975, a proportion of income generated by the top 20 per cent of the population by income (the fifth quintile) in total income has risen.[21] Since PIT is a progressive tax, this means higher tax revenue and a larger role for the automatic stabilizer.

Demographic conditions also contributed to an improvement in the budget. Since the 1980s, the proportion of working and elderly population in total population has increased.[22] Even though this implies higher elderly-related expenditures in the future, government entitlement programs were not implemented in Thailand. The demographic transition mainly translated into an expanded tax base and higher government revenue from PIT.

Figure 1.6: Population transition



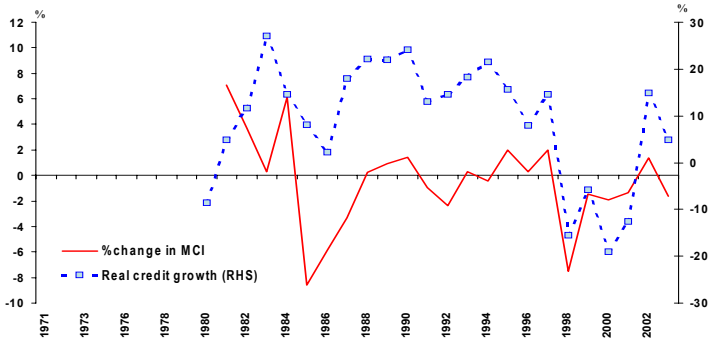
During the mid-1990s, the period that coincided with financial liberalization, GDP growth was exceptionally high, and real GDP was above its long-term trend. Fiscal policy became however more neutral after 1992 with the structural budget surplus declining from 6.1 per cent of GDP in 1990 to only 0.4 per cent in 1996. A large part of the increase in the expenditure during those years was classified as capital expenditure. Instead of moderating

[21] The peak was in 1992 when the fifth quintile generated 58.5 per cent of total income.

[22] National Economic and Social Development Board (NESDB)'s estimate shows that working and elderly population tends to account for 75 and 80 per cent of total population in 2010 and 2020 respectively.

government investment and acting counter-cyclically to the booming private investment, there was not sufficient pullback on the part of fiscal policy.

Figure 1.7: Percentage change in MCI and real credit growth



The role of monetary policy in this regard was rather limited due to exchange rate targeting. Real credit expansion, which the financial liberalization helped fuel, coupled with more neutral MCI suggest that monetary policy was not responding to the business cycle. With the benefit of hindsight, had fiscal and monetary policy been more forward-looking, the policy authorities could have chosen a more counter-cyclical combination of policies to moderate future economic volatilities, given the nature of the shocks in the context of the global economy.

In sum, fiscal policy during 1987-1997 was in broad support of the exchange rate peg, which was aimed to enhance growth through capital inflows attraction. Both monetary and fiscal policies were in neutral after 1992, when they should have been, in retrospect, more counter-cyclical. Fiscal policy rule at the time was to target nominal central government primary surplus, the target to which the fiscal authority became more committed. However, the notion of public sector budget balance and contingent public sector liabilities and the issue of forward-looking policy making were not fully appreciated before 1997. There was no apparent evidence to suggest that inflation was a direct target at any time during the period.

Post-1997: Immediately after the 1997 Asian crisis, the Bank of Thailand let the baht float almost freely for a period of time. The monetary rule followed changed from exchange rate targeting to monetary-base targeting under an influence of the IMF's adjustment programs, and later to inflation targeting since May 2000.

The levels of and changes in MCI reveal a continuation of accommodative monetary policy during the recession and low inflation period that ensued after the crisis. A sizeable depreciation of the baht and a decline in interest rates confirms that monetary policy intended to be counter-cyclical.

Fiscal policy has also been counter-cyclical, with the structural deficit increasing to more than 5 per cent of GDP, while the measured CBB became larger than ever as real GDP swung further below trend. The proportion of PIT in total government revenue has risen markedly over the last 30 years: from 8.2 per cent during 1970-86 to 10 per cent during 1987-1996 and to 12 per cent after 1997. The government also attempted to enhance the speed and effectiveness of budget disbursement by introducing front-loaded expenditure and fostering

disbursement of funds by government agencies. In 2003, total disbursement rate reached 91 per cent while that of capital expenditures was up to 77 per cent. As real GDP starts to return to its long-term trend, the desired size of fiscal deficit becomes smaller and a balanced budget is proposed for the fiscal year 2005.

Post-1997, monetary policy has followed a flexible inflation targeting rule with the core inflation target of 0-3.5 per cent, using short-term interest rate as an instrument while the exchange rate is managed floating. The fiscal authority has also followed a highly counter-cyclical target of nominal public sector budget deficit, of which it announces only the central government's on-budget part. Evidence that there is a joint monetary-fiscal targeting rule in Thailand is non-existent.

2. The model and the policy problem

The model outlined and used in this paper is that from Benigno and Woodford (2003).[23] We use this model because it recognizes short-term structural reality in the Thai economy--specifically, the assumptions about the economic environment of the model approximate well the fact that (a) like most advanced economies, the Thai government's major sources of revenue are distortionary taxes (as lump-sum taxes are not available and seigniorage forms only a minute part of government revenue) and (b) prices in Thailand display a degree of stickiness (so fully flexible prices assumed in much of the optimal policy literature are not realistic).[24]

The model economy consists of 3 sectors, namely those of the households, firms, and government (fiscal and monetary authorities). Let $t \in \{1,2,3,...\}$ denote the time period in this model economy, and $i \in [0,1]$ denote the type of consumption goods produced and consumed. The household sector consists of a measure 1 of infinitely-lived atomless households. At the beginning of each period *t*, each household is endowed with one unit of labor services.

Preferences: Each representative household has a preference over consumption and leisure, which can be represented by an additively separable, strictly concave utility function U with (the Dixit-Stiglitz composite basket of) consumption and leisure (or negative labor services) as its arguments.[25] The representative household consumes all types of goods and supplies all types of labor. That is, at the beginning date, each household maximizes

$$U_{t_0} \equiv E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} \left[\tilde{u}(C_t;\xi_t) - \int_0^1 \tilde{v}(H_t(j);\xi_t)dj \right], \tag{2.1}$$

[23] Here, we only give the background and our reinterpretation of the model for the sake of completeness. We make adjustments to allow the numerical results to conform to long-term stylized facts of Thailand. Further details the approximation method used to characterize the solution to the optimization problem, and the derivation of the structural equations of the model can be found in Benigno and Woodford (2003) and Woodford (2003, chapters 3-4).

[24] The distinction between fully flexible and (even slightly) sticky price environments is made because they matter for policy.

[25] This type of utility function (with an integral over various consumption goods) signifies benefits from variety. The idea owes to Dixit and Stiglitz (1977).

subject to the intertemporal budget constraint

$$\sum_{t=t_0}^{\infty}\left(\int_0^1 p_t((i);\xi_t)\cdot c_t((i);\xi_t)di\right)\leq\sum_{t=t_0}^{\infty}\left(\int_0^1 w_t((j);\xi_t)\cdot H_t((j);\xi_t)dj\right) \tag{2.2}$$

where $$C_t\equiv\left(\int_0^1 c_t(i)^{\frac{\theta}{\theta-1}}di\right)^{\frac{\theta-1}{\theta}}, \tag{2.3}$$

is a Dixit-Stiglitz aggregate basket of consumption comprising each of a continuum of differentiated goods, $c_t(i)$; $\beta\in(0,1)$ is the subjective discount parameter measuring the household's degree of time preference; $\theta>1$ is the elasticity of substitution between the differentiated goods; $H_t(j)$ is the amount of labor of type *j* supplied; ξ_t is the complete vector of exogenous disturbances to be fully defined shortly; and wages and prices $\{w_t(j),p_t(i)\}$ are defined below.[26]

Technology: There is a measure 1 of monopolistically competitive firms, each one producing one differentiated goods. There are an infinite number of industries, each producing many goods. Each industry *j* employs only labor of type *j*. Every firm uses a common production function, with labor as the only variable input,

$$y_t(i)=f(A_t,h_t(i))=A_t(h_t(i))^{1/\phi}, \tag{2.4}$$

where A_t is the exogenous technology factor and $\phi>1$, so that the production function is strictly concave with diminishing marginal product of labor. The labor share of income or output for this economy is simply $1/\phi$. There is no capital and therefore no explicit dynamic of investment or capital in this model. Capital and investment are subsumed under the exogenous technology factor, A_t.[27]

Wages and prices: Firms are wage-takers. Wages are assumed to be fully flexible. The real wage demanded by labor of type *j* carries a variable exogenous markup factor, $\mu_t^w\geq 1$, over marginal disutility of work:[28]

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[26] Attention is restricted, for simplicity, to the isoelastic functional form $\tilde{u}(C_t;\xi_t)\equiv\frac{C_t^{1-\tilde{\sigma}^{-1}}\overline{C}_t^{\tilde{\sigma}^{-1}}}{1-\tilde{\sigma}^{-1}}$, and $\tilde{v}(H_t;\xi_t)\equiv\frac{\lambda}{1-\nu}H_t^{1+\nu}\overline{H}_t^{-\nu}$, where $\tilde{\sigma},\nu>0$, and $\{\overline{C}_t,\overline{H}_t\}$ are bounded exogenous disturbance processes.

[27] Note here that later when we calibrate to restrict this model to the Thai economy, all growing macroeconomic aggregates will be assumed to have a deterministic trend (based on historical values) with stochastic terms attached to them, so that they vary stochastically around that deterministic trend. The stochastic processes chosen will mimic those that we think are likely, based on past experiences shown in the data for Thailand.

[28] The variable wage markup factor is assumed so that we may include the possibility of a "pure cost-push shock" that affect equilibrium pricing behavior. This will eventually appear in the short-run aggregate supply

$$w_t(j) = \mu_t^w \frac{\tilde{v}_h(H_t(j);\xi_t)}{\tilde{u}_c(C_t;\xi_t)} \tag{2.5}$$

Monopolistically competitive firms in each industry set prices for a random interval of time. The fraction of prices that remain unchanged in any period is captured by $\alpha \in [0,1)$. Each firm sets a price for its differentiated goods, $p_t(i)$, to maximize expected profit,

$$E_t\left\{\sum_{T=t}^{\infty} \alpha^{T-t} Q_{t,T}\, \Pi\left(p_t(i), p_{Tt}^j, P_T; Y_T, \tau_t, \xi_T\right)\right\},$$

where the aggregate demand index, Y_t, can be given thus:

$$Y_t \equiv \left(\int_0^1 \mathrm{y}_t(i)^{\frac{\theta}{\theta-1}} di\right)^{\frac{\theta-1}{\theta}}, \tag{2.6}$$

and given the stochastic financial discount factor used to determine the nominal value of a claim in period t to income in period T, $Q_{t,T}$; a series of industry j price level, the aggregate price level (defined below), aggregate production or demand, the tax rate on the sales revenue, and the exogenous disturbance processes, respectively.[29] [30] The aggregate (Dixit-Stiglitz) price index is given by

$$P_t \equiv \left[\int_0^1 p_t(i)^{1-\theta} di\right]^{\frac{1}{1-\theta}}. \tag{2.7}$$

The relative price index at each date can be constructed as a measure of price dispersion,

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relation. It is also relevant in the case that there is organized labor in industry j, whose power varies perhaps according to the stages of the business cycles. The possibility of a "pure cost-push" disturbance will allow us to analyze implications on real allocations and prices from the effect of the shock that originates from the cost-structure of the firms (the aggregate supply relation).

[29] Profit is after-tax sales revenue net of the wage bills. The profit function of a firm in an industry j, $\Pi(\cdot)$ is defined as:

$$\Pi\left(p, p^j, P; Y, \tau, \xi\right) \equiv (1-\tau) p Y (p/P)^{-\theta} - \mu^w \left(\frac{\tilde{v}_h\left(f^{-1}\left(Y\left(p^j/P\right)^{-\theta}/A\right);\xi\right)}{\tilde{u}_c(Y-G;\xi)} P \cdot f^{-1}\left(Y\left(p^j/P\right)^{-\theta}/A\right)\right)$$

[30] The term α^{T-t} indicates the probability that a price the firm chooses in period t will remain in period T.

$$\Delta_t \equiv \int_0^1 \left(\frac{p_t(i)}{P_t} \right)^{-\theta(1+\omega)} di, \tag{2.8}$$

where $\Delta_t \geq 1$ and $\omega \equiv \phi(1+\nu) - 1$, $\omega \in \Re_{++}$, is the elasticity of real marginal cost in an industry with respect to industry output. The objective function of the household can be rewritten as

$$U_{t_0} \equiv E_{t_0} \sum_{t=t_0}^{\infty} \beta^{t-t_0} U(Y_t, \Delta_t; \xi_t). \tag{2.9}$$

In equilibrium, the stochastic financial discount factor is the discounted ratio of intertemporal marginal utilities from consumption adjusted for inflation in the intervening periods $T - t$,

$$Q_{t,T} = \beta^{T-t} \frac{\tilde{u}_c(C_T; \xi_T)}{\tilde{u}_c(C_t; \xi_t)} \frac{P_t}{P_T}. \tag{2.10}$$

Every firm in an industry *j* changes their prices at the same time. In equilibrium, after revising their prices in period *t,* each firm chooses the same new price p_t^*. It is then easy to show that the law of motion for the aggregate price index is given by[31]

$$P_t = \left[(1-\alpha) p_t^{*1-\theta} + \alpha P_{t-1}^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{2.11}$$

Because the relative prices remain the same in those industries that do not revise their prices in period *t,* we can obtain a law of motion for relative prices through the law of motion for the aggregate price index as follows:

$$\Delta_t = \Xi\left(\Delta_{t-1}, \frac{P_t}{P_{t-1}} \right). \tag{2.12}$$

Since these relative prices go into household utility function, and therefore matter for (expected) welfare, this is the source of welfare loss from inflation or deflation in this model. Notice that in the case where prices are fully flexible $(\alpha = 0)$, $P_t = p_t^*, \forall t$ (according to the law of motion) and $\Delta_t = 1$ regardless of the rate of inflation. In this case, *expected* inflation or deflation does not cause welfare loss. Indeed, in the case of fully flexible prices, *expected* inflation does not matter for welfare.

[31] For details on how to derive the law of motion for the general price level, see Woodford (2003), pp. 177-9.

Note that welfare loss from inflation or deflation (i.e. deviation from price stability) in this model comes specifically from the fact that prices are not fully flexible and therefore current-dated relative prices (or the measure of price dispersion) cannot reach 1 immediately when the economy is faced with a potential disturbance. That is, nominal price rigidity, which is modeled through staggered price contracts that has just been defined, prevents firms from adjusting prices in a timely fashion to respond to the economic shocks that they face. This nominal price rigidity causes expected inflation or deflation to have welfare losses, through households' relative quantity demanded of the differentiated goods that are expressed as a function of relative prices. When prices of differentiated goods cannot adjust immediately in response to shocks, household's relative quantity demanded for these goods is distorted from that which would be the case under fully flexible prices. For example, households will consume different amount of each differentiated good even though they wish to consume the same amount of each under flexible prices, and this affects welfare.

The government sector: The government sector obtains an exogenously given quantity of the Dixit-Stiglitz composite goods from the firms in each period in a cost-minimizing fashion. In equilibrium, the government will allocate its purchases across supplying firms in the same proportion as do households, and the exogenous government demand for the composite goods can be given as,

$$G_t = Y_t - C_t . \tag{2.13}$$

The government pays for these goods and services through distortionary taxes levied on firms[32] and borrowing, to be elaborated below under the bond market section.

The central bank: The central bank controls the risk-free short-term nominal interest rate, i_t.[33] This short-term nominal interest rate is related, in equilibrium, to other financial asset prices (short-term government bonds) through the arbitrage relation and the standard intertemporal marginal utility ratio condition, respectively,

$$1 + i_t = \left[E_t Q_{t,t+1}\right]^{-1} = \beta^{-1}\left\{E_t \frac{\widetilde{u}_c\left(Y_{t+1} - G_{t+1};\xi_{t+1}\right)}{\widetilde{u}_c\left(Y_t - G_t;\xi_t\right)}\frac{P_t}{P_{t+1}}\right\}^{-1} . \tag{2.14}$$

In this case, it is assumed that zero lower bound for nominal interest rates never binds *under the optimal policies* considered in this paper. This assumption is justified by the fact

[32] Since households own firms, they are also taxed ultimately. Assume that all of the taxes levied are through firms simplifies the matter, as we do not have to attach profit or labor taxes to household's budget constraint. In this case, there is only one type of tax levied on firm's profit, effectively. Our major results would not change if households were also taxed at the same rate instead of firms.

[33] We abstract away from monetary frictions; that is from positive transaction demand for money and therefore cash. We are assumed to operate in a cashless world ("in the cashless limit"). This is not wholly unrealistic considering that cash is a minor fraction of "money" transactions used in advanced economy. This model place more emphasis on the continuing trend of financial innovation away from cash. In any case, Woodford (2003) shows that model's predictions and policy conclusions derived thereof will not change even if we include cash in the model. The cashless limit is assumed only to simplify matters.

that under optimal policy rules, in the absence of disturbances, the nominal interest rate equals the real interest rate, $\bar{r} = \beta^{-1} - 1 > 0$.[34]

The bond market and government solvency condition: All public debt is assumed to consist of risk-free nominal one-period bond. Since we aim to calibrate a quarterly model, these nominal bonds are equivalent to 90-day treasury bills, and the risk-free assumption is therefore not unrealistic. The government can roll over its debt and the nominal value of end-of-period public debt B_t follows the law of motion,

$$B_t = (1 + i_{t-1})B_{t-1} + P_t s_t, \tag{2.15}$$

where the real primary (i.e., before interest payment) budget balance (surplus) is defined as

$$s_t \equiv \tau_t Y_t - G_t - \zeta_t. \tag{2.16}$$

That is, the real primary surplus in each period equals total revenue (and grants) less real (lump-sum) government purchases of goods and services from the private sector G_t and real (lump-sum) transfers from the government to the private sector ζ_t. Both G_t and ζ_t are exogenously given to represent exogenous fiscal needs. This way we can analyze a "purely fiscal" disturbance, which carry implications for the real allocation purely through its effect on the government budget. The effective tax rate τ_t is the key fiscal policy decision (instrument) in each period, and is calculated as the share of the national product that the government collects as tax revenue in period *t*.

Woodford (2003, chapter 2) demonstrates a requirement of rational-expectations equilibrium (specifically from household optimization together with market clearing conditions) that the expected path of government budget balances must satisfy an intertemporal solvency condition in each state of the world that may be realized at date *t* (henceforth, the government solvency condition or GSC),

$$\frac{b_{t-1}}{P_t / P_{t-1}} = E_t \sum_{T=t}^{\infty} \left(\frac{Q_{t,T}}{P_T / P_t} \right) \cdot s_T, \tag{2.17}$$

where $\frac{Q_{t,T}}{P_T / P_t}$ is the stochastic discount factor for a real income (surplus or deficit) stream. A crucial point is that this condition restricts the possible paths for the tax rate $\{\tau_t\}$ that may be chosen in equilibrium.

It is obvious from the law of motion governing public debt dynamics and the government intertemporal solvency condition that, despite our abstraction from monetary

[34] The absence of a zero bound also simplifies matter, as we need not introduce an additional constraint on the possible paths of allocations and prices so that they are consistent with a non-negative nominal interest rate.

frictions and cash (and therefore seigniorage), monetary policy through central bank's *interest rate decision* and its influence on resulting equilibrium inflation have fiscal consequences, specifically on the *real* burden of public debt. This is how this model recognizes the reality of tangible fiscal consequences of monetary policy.

Policy goal: In brief, fiscal and monetary policy (so far, sequences of $\{i_t, \tau_t, b_t, s_t\}$) is chosen to maximize the level of expected welfare (utility) of a representative household from the initial date t_0 onward under the standard Ramsey approach, given initial level of public debt and prices. Optimal policy from date t_0 onward, or a t_0-optimal plan, requires commitment if there is positive probability that the corresponding *t*-optimal plan at some later date *t* may depart from the t_0-optimal plan.[35] In other words, the t_0-optimal plan is the best plan under the constraints on what can be achieved at date t_0, consistent with the existence of a rational-expectations equilibrium (allocations and prices). Such a plan depends on the expected path of inflation, output and taxes at other future dates. In the absence of a commitment, a planner would have no incentive to choose a policy at a future date *t* that is consistent with the expectations that it was desirable to create at the earlier date t_0. The degree of pre-commitment needed is of a limited sort, however.[36] Woodford (2003, chapter 7) calls this time-invariant policy rule "optimal from a timeless perspective", i.e. at any date.

[35] This is what is generally known as the "time inconsistency" problem.

[36] See Benigno and Woodford (2003, Appendix A2) on how to characterize the Ramsey problem as a recursive problem. Because of the recursive form of the problem, it is possible for a commitment to a time-invariant policy rule from date *t* onward to implement an equilibrium that solves the problem, under some initial commitment.

3. The linear-quadratic policy problem and optimal policy rules

The solution to the Ramsey problem above can be characterized and, equivalently, the derivation of optimal time-invariant policy rules obtained using a linear-quadratic approximation technique. The solution is characterized only for initial conditions near certain steady-state values, so that local approximation can be used to characterize optimal policy. Benigno and Woodford (2003) establishes that if one starts from initial conditions close enough to these steady-state values, the existence of which can be established, and exogenous shocks thereafter are small enough, *the optimal policy* (subject to initial commitments) remains forever near the steady state. The local approximation characterizes a policy that is optimal and time-invariant in the event of small disturbances, which is more relevant for those that are not of the making of a great depression, for example.

Steady-state values: In characterizing the steady state values, we depart in a minor way from Benigno and Woodford (2003) to give the exogenous technology factor, output and its components a similar deterministic positive trend (growing at the same exogenously given positive rate) so as to be consistent with the concept of "balanced growth" in the economic growth literature and long-run evidence in the data from developed and emerging economies.[37]

That is, in a purely deterministic case, steady state means that for all $t \geq t_0$, exogenous disturbances $\overline{C}_t, \overline{H}_t, G_t, \zeta_t, A_t$ now take on constant-positive-growth values $\overline{C}, \overline{H}, \overline{G}, \overline{\zeta}, \overline{A}$ and μ_t^w takes on a constant value $\mu^w > 0$, assuming that initial real public debt $b_{t_0-1} = \overline{b} > 0$.[38]

The associated steady-state tax rate is therefore given by

$$\overline{\tau} = \frac{\overline{G} + \overline{\zeta}}{\overline{Y}} + (1-\beta)\frac{\overline{b}}{\overline{Y}}, \tag{3.1}$$

where $\overline{Y}$ is steady-state output that grows at a constant rate. It can easily be shown that $0 < \overline{\tau} < 1$.

Additionally, as in Benigno and Woodford (2003), regardless of the initial public debt, inflation is constant at zero in this deterministic steady state (correspondingly, zero price dispersion or the measure of price dispersion is 1).

The Ramsey problem can be represented in another manner, which has, among other things, the advantage of being more familiar and pertinent to policy makers. That is, the

[37] An economy is said to be on a balanced growth path if aggregate output, aggregate government expenditure, and aggregate consumption all grow at the same constant rate as that of the exogenous technology factor.

[38] As we shall see later, the last assumption is not unrealistic, as Thailand's current real public debt hovers around 57 per cent of annual GDP (as of 2001) and we plan to limit our *steady-state* real public debt at 60 per cent of annual GDP, using the Maastricht Treaty's upper bound as a guide for the steady state value.

policy problem can be *approximated* as the following linear-quadratic problem, the computation and setup of which can be found in Benigno and Woodford (2003, appendixes 4-9). At this point, we wish to go straight to the policy problem and move on to show results that may be relevant to Thailand, going forward.

A quick note regarding notations from this point onward: ^ attached to a variable x denotes percentage (or log) deviation of that variable from its steady state value, $\bar{x}$ denotes steady-state value for variable x, and * attached to a variable denotes the target level at which policy should pursue for that variable.

3.1 The approximate policy problem

For the purpose of characterizing optimal time-invariant policy, it suffices that policies are ranked according to the value that they generate for the loss function:

$$E_{t_0}\sum_{t=t_0}^{\infty}\beta^{t-t_0}\left\{\frac{1}{2}q_y\cdot y_t^2+\frac{1}{2}q_\pi\cdot\pi_t^2\right\}, \tag{3.2}$$

where a lower value for the losses implies a higher welfare level. This quadratic loss function consists of 2 arguments: (1) a measure of the "output gap" $y_t \equiv \hat{Y}_t - \hat{Y}_t^*$, where $\hat{Y}_t$ denotes the percentage (or log) deviation of current output level from steady state output $\bar{Y}$ and $\hat{Y}_t^*$ is the percentage deviation of the target output level away from steady state output.[39] The latter target output is a measure of the so-called "potential output". The target level of output depends on the various exogenous disturbances and hence need not remain constant when the disturbances take on non-zero values. Since both are in percentage deviation away from steady-state output, their difference y_t is simply percentage difference between current output and the level of output at which policy should be targeting. (2) π_t denotes the logarithm of the gross inflation rate (the simple ratio of prices, P_t/P_{t-1}), which equals 1 plus the net inflation rate, $\frac{P_t - P_{t-1}}{P_{t-1}}$.[40]

The weights or degree of importance society attaches, and so should policy makers, to the "output gap" and the inflation rate are $q_y, q_\pi > 0$, the precise mathematical definitions of which are given in the appendix. In words, these weights depend on the structure of the economy, i.e. preference parameters of the household, steady-state tax rate[41], relative size of government expenditure compared to budget surplus in the steady state, gross markup in the labor market, the technology parameter (or the labor share of income). The weight attached

[39] That is, $\hat{Y}_t \equiv \log\left(Y_t/\bar{Y}\right)$ and $\hat{Y}_t^* \equiv \log\left(Y_t^*/\bar{Y}\right)$.

[40] As the gross inflation rate equals 1, the net inflation rate equals 0, (i.e. complete price stability), $\pi_t = 0$.

[41] Since the only tax available to the government (in the real world and also in the model) is distortionary, the steady-state wedge between efficient steady-state output under lump-sum taxation and the steady-state output in the presence of positive distortionary taxation is positive. That is, the inefficiency (in a Pareto sense) of the steady-state output is partly due to distortionary taxation. This is partly the reason why the size of the steady-state tax rate matters for the weights society chooses to attach to their stabilization goals.

to inflation depends additionally on the degree of price stickiness and the degree of substitutability between goods in the consumption basket (i.e. the elasticity of substitution).

The log-linear approximation to the structural constraints in the policy problem outlined in the previous section, given in Benigno and Woodford (2003, appendixes 4-9) gives 2 structural relations as constraints for the approximate policy problem. They are the aggregate supply relation and the intertemporal government solvency condition (GSC), both in log-linear forms.

The aggregate supply relation is given as

$$\pi_t = \kappa\left[y_t + \psi\hat{\tau}_t + u_t\right] + \beta E_t\pi_{t+1}, \tag{3.3}$$

or, alternatively,

$$\pi_t = \kappa\left[y_t + \psi\left(\hat{\tau}_t - \hat{\tau}_t^*\right)\right] + \beta E_t\pi_{t+1}, \tag{3.4}$$

where the coefficient $\kappa > 0$ is the measure of the degree of price stickiness. The tax rate variable $\hat{\tau}_t$ denotes the percentage deviation of current-date effective tax rate from its steady-state level $\bar{\tau}$. We can interpret $\hat{\tau}_t^*$ as the current-period effective tax change *needed* to offset the composite cost-push shock $u_t \equiv -\psi\hat{\tau}_t^*$ in order to allow for simultaneous stabilization of both inflation and the "output gap", the value of which depends on the multiplier $\psi > 0$. The composite cost-push shock term u_t simply indicates the degree to which the various exogenous shocks summarized in ξ_t can successfully obstruct a simultaneous goal of stabilizing inflation, the "output gap" and the tax rate.[42] The precise mathematical definition of the term u_t in terms of ξ_t is given in the appendix.

The coefficient κ is also the slope of the aggregate supply curve, which describes a relationship between the current rate of inflation on the one hand and the "output gap", the cost-push factors including tax rates that weighs on firms' marginal cost and the discounted expected inflation rate. In short, the aggregate supply relation gives the interaction between changes in inflation from one period to the next and the current "output gap" and other "marginal-cost-push" factors.[43]

The disturbance term ξ_t is defined as a vector of various exogenous economic shocks: $\xi_t' \equiv \left\langle \hat{\zeta}_t \quad \hat{G}_t \quad g_t \quad q_t \quad \hat{\mu}_t^w \right\rangle$, where $\hat{\zeta}_t \equiv \left(\zeta_t - \bar{\zeta}\right)/\bar{Y}$ denotes the extent that the

[42] It is called the composite cost-push shock because it summarizes the effect of all exogenous shocks that originate in or affect the aggregate supply relation, i.e. aggregate marginal cost relation of firms.

[43] Note that in the case where lump-sum tax is available and there is no use of distortionary taxation, our aggregate supply relation would look exactly like the familiar "New-Keynesian Phillips curve": $\pi_t = \kappa y_t + \beta E_t\pi_{t+1}$. In the case of lump-sum taxation, the weights society would attach to the "output gap" and the inflation rate in the loss function would simply be: $q_y = \omega + \sigma^{-1} > 0, q_\pi = \frac{\theta}{\kappa} q_y > 0.$

level of government transfer to the private sector deviates from its steady-state value measured relative to steady-state output level; $\hat{G}_t \equiv \left(G_t - \overline{G}\right)/\overline{Y}$ denotes the extent that the level of government purchases deviates from its steady-state level, measured as a share of the steady-state national product; $g_t \equiv \hat{G}_t + \left(\overline{C}/\overline{Y}\right)\log\left(C_t/\overline{C}\right)$ denotes the variation in log output required in order to maintain a constant marginal utility of real income;[44] $q_t \equiv \omega^{-1}\left[\nu\left(\log\left(H_t/\overline{H}\right)\right) + \phi(1+\nu)\left(\log\left(A_t/\overline{A}\right)\right)\right]$ denotes the variation in log output required in order to maintain a constant marginal disutility of work to supply output;[45] and finally $\hat{\mu}_t^w \equiv \log\left(\mu_t^w/\overline{\mu}^w\right)$ or simply the percentage (or log) deviation of gross markup in the labor market away from its steady-state value.

The other constraint on possible equilibrium paths is that of the GSC. A log-linear approximation to the GSC above is given thus,

$$\hat{b}_{t-1} - \pi_t - \sigma^{-1} y_t + f_t = (1-\beta) E_t \sum_{T=t}^{\infty} \beta^{T-t}\left[b_y y_T + b_\tau\left(\hat{\tau}_T - \hat{\tau}_T^*\right)\right]. \tag{3.5}$$

Or alternatively in a "flow" form, $\forall t \geq t_0$,

$$\begin{aligned} \hat{b}_{t-1} - \pi_t - \sigma^{-1} y_t + f_t = {} & (1-\beta)\left[b_y y_T + b_\tau\left(\hat{\tau}_T - \hat{\tau}_T^*\right)\right] \\ & + E_t \beta\left[\hat{b}_t - \pi_{t+1} - \sigma^{-1} y_{t+1} + f_{t+1}\right] \end{aligned} \tag{3.6}$$

together with a transversality condition to ensure that the debt path does not explode in the distant future. The coefficient $\sigma \equiv \tilde{\sigma} \cdot \left(\overline{C}/\overline{Y}\right) > 0$ is the intertemporal elasticity of substitution of private expenditure; the coefficients $b_\tau = 1 + \omega_g; b_y = b_\tau - \sigma^{-1}$, where $\omega_g = \left(\overline{G} + \overline{\zeta}\right)/\overline{s}$. The term f_t is a composite measure of exogenous "fiscal stress," measuring the extent to which various disturbances affect the government solvency condition. The fiscal stress is a function of various disturbances summarized in ξ_t, defined above, and structural parameters of the economy. It is given by

$$f_t \equiv h_\xi' \xi_t - (1-\beta)\sum_{T=t}^{\infty} \beta^{T-t} f_\xi' \xi_t\,, \tag{3.7}$$

where the coefficients are defined in the appendix.

The fact that the GSC is another constraint on possible (not necessarily equilibrium) paths of inflation implies that fiscal policy commitment may not be *Ricardian*, i.e. there is some price path that will violate the GSC or make the debt path explode. This is the underlying result why there is an effect of fiscal disturbances (stress) on the price level in

[44] Holsing marginal utility of real income fixed and vary income implies that this is a preference shock.
[45] Holding labor input constant and vary output implies that this is a TFP shock.

equilibrium, which will have to be countered by policy.[46] In this model, the effect of fiscal developments on inflation cannot be explained by the fact that the money supply expands when the government budget deteriorates or in anticipation of future fiscal stress.

Indeed, the model's construction is based on the theory that explains inflation determination as follows: the price level adjusts as necessary to maintain the intertemporal GSC. The basic economic mechanism is the wealth effect of fiscal stress on private expenditure (i.e. on optimizing private agents' budget constraints). The *expectation* that government primary surplus will fall makes households feel wealthier, as they can afford a greater *sum* of private and government expenditure (given their expected after-tax income and expected government purchases on their behalf). This positive wealth effect from lower surplus then leads them to demand goods and services in excess of those the economy can supply (aggregate demand rises above potential output, $\hat{Y}_t > \hat{Y}_t^*$), unless prices rise. A sufficient rise in prices can restore equilibrium by reducing the real value of privately held nominal assets (or equivalently, the real value of the government nominal liabilities). Prices stop rising when the real value of those nominal assets (bonds) equals the present value of expected future primary surpluses (see the GSC) since only then will total expenditure (private plus public) that households can afford be exactly equal to what society can produce (actual output equals potential output, $\hat{Y}_t = \hat{Y}_t^*$), and equilibrium is restored. Such is the basis of the fiscal theory of the price level.[47]

One can see in the analysis above that even if we include money stock in our analysis, the inflationary effects of fiscal stress do not relate primarily to changes in expected seigniorage revenues, or the expansion of the monetary base to accommodate fiscal needs (monetization of debt, so to speak) like economic textbooks usually discuss.[48]

In summary, the "approximate" policy problem can be defined as follows:

Definition (*Rational-Expectations Equilibrium*): The rational-expectations equilibrium is a sequence of state-contingent paths for the endogenous prices, allocations, tax rates, and public debt $\left\{\pi_t, y_t, \hat{\tau}_t, \hat{b}_t\right\}_{t=t_0}^{\infty}$ from some initial date t_0 onward such that these endogenous variables satisfy the policy maker's objective of minimizing welfare loss according to (3.2) subject to the short-run aggregate supply relation (3.3 or 3.4) and the government intertemporal solvency condition (3.5) in each period, and the "commitment" constraints that

[46] If the fiscal policy is Ricardian, then fiscal stress would have no consequences on aggregate demand in a rational-expectations world with frictionless financial markets, as the private sector will discount today's expansionary effect of a budget deficit by future need for a budget surplus and will not adjust their consumption behavior as a result.

[47] For followers of the quantity theory of money, this is a disturbing story. Fiscal disturbances do affect the equilibrium growth rate of the money supply, but the causality is not from the government budget to money supply growth and then from the money supply growth to inflation. Rather, the government budget affects the general level of prices as elaborated above, and higher prices result in higher demand for money, which the central banks (using interest rate as an instrument) elastically or passively accommodates leading to rising money supply.

[48] In the cashless limit we describe in the model so far, seigniorage becomes so negligible a part of the government budget. This fits well with the empirical regularities we find for Thailand as well as other advanced economies. So having no money in the utility function or a money demand equation does not matter at all for our analytical results or imply that the model is unrealistic.

π_{t_0} and y_{t_0} equal certain precommitted values $\overline{\pi}_{t_0}, \overline{y}_{t_0}$ respectively,[49] given an initial real public debt value b_{t_0-1} and the exogenous disturbance processes $\{\hat{\tau}_t^*, f_t\}$.

Since the objective function is strictly convex (quadratic) and the constraint set linear, a unique bounded solution to the minimization problem exists. We first briefly characterize the state-contingent paths of the endogenous variables in response to exogenous shocks in the case of nominal rigidity (sticky prices, i.e. $\alpha > 0$), and then quickly derive the optimal policy rules that should implement an equilibrium (solution outcome) of this kind. In addition, we shall derive a target-consistent interest rate rule (reaction function) that will implement this equilibrium from the central bank's point of view.

3.2 Optimal targeting rules and fiscal policy-instrument rules

Let $\varphi_{1t}, \varphi_{2t} > 0$ be the Lagrange multipliers (shadow value in marginal utility terms) attached to the aggregate supply relation and the GSC, respectively. Then, the first-order conditions for minimization with respect to $\{\pi_t, y_t, \hat{\tau}_t, \hat{b}_t\}$ (according to the policy problem defined above) can be obtained. These first order conditions along with the aggregate supply relation, the GSC, and the initial conditions can be solved for the following state-contingent paths or the evolutionary dynamics of the shadow value in units of marginal utility of additional government revenue (or φ_{2t}), public debt, inflation, and the "output gap", as listed here:

$$\begin{aligned} \varphi_{2t} &= \Omega_1 \varphi_{2,t-1} - \Omega_2 \left(f_t + \hat{b}_{t-1} \right), \\ \hat{b}_t &= -E_t f_{t+1} - \Omega_3 \varphi_{2t}, \\ \pi_t &= -\Omega_4 \left(\varphi_{2t} - \varphi_{2,t-1} \right), \\ y_t &= \Omega_5 \varphi_{2t} + \Omega_6 \varphi_{2,t-1}, \end{aligned} \tag{3.6}$$

where the constants $\Omega_1, \Omega_2, \Omega_3, \Omega_4, \Omega_5$ and Ω_6 are combinations of the structural parameters of the economy as given in the appendix.

The state-contingent path of the tax rates that is consistent with the dynamics of inflation and the "output gap" is obtained from the aggregate supply relation; that is,

$$\hat{\tau}_t = \hat{\tau}_t^* + \psi^{-1} \left[\kappa^{-1} \left(\pi_t - \beta E_t \pi_{t-1} \right) - y_t \right] \tag{3.7}$$

It follows that the public sector budget balance (as a percentage of GDP) to be announced and committed to by the fiscal authority is given by the surplus identity above.

It is important to note that the optimal dynamics of inflation, the "output gap", and public debt depends solely on the evolution of the composite fiscal stress variable, whereas

[49] That is, the deterministic steady state values of inflation and the "output gap" committed to at the initial date.

the dynamics of the tax rate depends also on the evolution of the composite cost-push variable $u_t \equiv -\psi \hat{\tau}_t^*$. Hence fiscal stress is a crucial summary statistic of disturbances buffeting the economy.

We next characterize the optimal targeting or optimal policy rules that are the result of the above first-order conditions to the defined policy problem.[50] Targeting rules here are specified in the spirit of Svensson (2003) and Giannoni and Woodford (2003) as "commitments by [monetary and fiscal] authorities to adjust their policy instruments [*however necessary*] to ensure that the projected paths of the endogenous variables satisfy certain target criteria."[51] These target criteria are not only consistent with the desired inflation and output outcome, but they also determine the most desirable rational-expectations outcome, ruling out equally possible, but undesirable ones, and bring about optimal responses to various specifications of economic disturbances.

By eliminating the Lagrange multipliers from the system of first-order conditions to the rational-expectations equilibrium problem above, one can obtain the target criteria in the form only of the target variables, in this case inflation and the "output gap", regardless of the specification of the disturbance processes. This way, the optimal target criteria are free of the disturbance terms and expressed in the form that is independent of the specification of the disturbances. Because the optimal targeting criteria expressed in the form of inflation and changes in the "output gap" are simple, they are useful for policy communication with the public; hence, their advantage.

The optimal target criteria are given by

$$\begin{aligned} \pi_t + \Psi_1 \pi_{t-1} + \Psi_2 \left(y_t - y_{t-1} \right) &= 0, \\ E_t \pi_{t+1} &= 0, \end{aligned} \tag{3.8}$$

where the weights $\Psi_1 \equiv \Omega_6 / \Omega_5$, $\Psi_2 \equiv \Omega_4 / \Omega_5$, which can be determined from the structural parameters of the economy.

We can see that these rules are called "optimal target criteria" because they are the welfare-maximized benchmark for policy success that is expressed solely in the form of the targets.

The target criteria obtained in this fashion are of the "flexible inflation targeting" form with commitment to near-term inflation and the projected rate of change of the near-term output gap (not the levels of the output gap) in addition to commitment to zero next-period inflation. Note that the first target criterion suggests that optimal policy should be path dependent, with last period inflation figured into the rule. This path dependency (or as Woodford (2003) calls "history dependence") signifies the benefit of convincing the public at

[50] Svensson (2003), Woodford (2003, chapter 7) demonstrate that, and according to Benigno and Woodford (2003), the approach taken thus far will determine an optimal (locally unique) rational-expectations equilibrium and rule out other equally likely but undesirable outcomes. That is, this approach is superior to those that solve for optimal state-contingent paths for the policy instruments directly.

[51] See Benigno and Woodford (2003), p.32.

earlier dates of the inflation goal and follow through on the promise to keep inflation there. That is, an appropriate rule should take advantage of the private sector's anticipation of policy at earlier dates.

Path dependency in this case implies the desirability that, at an earlier time, economic agents can count on the fact that the authorities will subsequently follow up on a certain policy in a predictable fashion. This way, to a large extent, the private sector can predict policy action at an appropriate time and the authorities can predict how the private sector will respond to anticipated policy action.[52] It is logical, as a result, to incorporate recent *past* (and not only future) conditions in setting current policy. The issue is that of taking advantage of private expectations to further the stabilization goals by shaping them *at earlier dates* to achieve a desirable outcome today and in the future, and having an explicit policy target works toward that end.

If the public can expect that this pair of target criteria will be jointly satisfied each period, then the resulting paths for the endogenous variables will be optimal responses to disturbances. In practice, with measurement errors in the consumer price inflation, we may interpret the zero next-period inflation commitment as a commitment to *low and stable* inflation (practically, price stability defined as the rate of inflation that does not play a part in the decision of households and firms regarding resource allocation). This is what the Bank of Thailand's commitment to maintain the *quarterly averaged* rate of inflation within the target range of 0 to 3.5 per cent per annum is primarily concerned with.

Since fiscal policy is conducted through variations in the effective tax rate and public debt, we have in effect presented in this section the optimal target-consistent fiscal policy instrument reaction functions. We are now ready to derive the monetary policy instrument rule or reaction function that is consistent with the joint target criteria above.

3.3 Interest rate reaction function of the central bank

Given that central banks use short-term interest rate as monetary policy instrument, finding an interest rate rule that is consistent with the target criteria above is useful as a guide to policy making. The interest rate reaction function can be derived from the intertemporal marginal utility condition, derived from household maximization problem and the government solvency condition above.

Since inertial interest rate adjustment is preferred for the reasons we have previously discussed, interest rate variations matter for welfare. In this case, the intertemporal marginal utility condition can be approximated as

$$y_t = E_t y_{t+1} - \sigma\left[i_t - E_t \pi_{t+1} - r_t^*\right], \tag{3.9}$$

where $r_t^* = \exp\left(\hat{r}_t^* - \log(\beta)\right) - 1$, and $\hat{r}_t^* \equiv \sigma^{-1}\left[\left(g_t - \hat{Y}_t^*\right) - E_t\left(g_{t+1} - \hat{Y}_{t+1}^*\right)\right]$. This relationship states plainly that the gap between the current real interest rate (the difference

[52] Policy makers should not dismiss the effects of private-sector expectations at earlier dates of a different *current* policy action from the one that policy makers may judge to be best today.

between nominal interest rate and expected inflation) and the desired (or equilibrium) real interest rate r_t^* should depend linearly on the rate of change of the "output gap".[53] That is, if we are on the steady-state or "balanced growth" path, where there are no disturbances and the equilibrium real interest rate is constant at $\beta^{-1} - 1 > 0$, the rate of change in the "output gap" is zero (that is, today and tomorrow's output levels are exactly at their respective steady state values) and expected inflation is zero, then nominal interest rate should be equal to the real interest rate at the level of the equilibrium real interest rate r_t^*.

If there are disturbances that put the economy off the balanced growth path, however, the rate of change in the "output gap" is no longer zero or the expected inflation rate is no longer zero, the gap between the real interest rate and the equilibrium real interest rate (the real interest rate gap) will change accordingly.

Combine the above relation with the intertemporal GSC,[54] we can obtain the following (forward-looking) "expectations-based" interest rate reaction function that is expressed in terms of the target variables and the exogenous disturbances, *taking as given* the paths of the fiscal policy instruments (public debt and taxes):

$$\begin{aligned} i_t &= r_t^* + \pi_t + (1-\beta)E_t\left[\sigma^{-1} y_{t+1} + \pi_{t+1}\right] \\ &\quad + \left\{-\left(\hat{b}_{t-1} + f_t\right) + (1-\beta)\left[b_y y_t + b_\tau\left(\hat{\tau}_t - \hat{\tau}_t^*\right)\right] + \beta E_t\left[\hat{b}_t + f_{t+1}\right]\right\} \end{aligned}$$

where the coefficients are as defined earlier.[55]

This is the policy instrument rule for the central bank that will implement, together with the tax and public debt paths that the fiscal authority should adopt (as outlined earlier), so that that the optimal target criteria in the previous section are simultaneously satisfied. This optimal target-consistent interest rate reaction function states that (short-term) policy interest rate should respond to both the "fiscal stress" and "cost-push" shocks in a forward-looking manner. It also responds to changes in the equilibrium real interest rate that depend on such shocks. It can be seen then that as long as the central bank can forecast correctly the paths of public debt and tax rates into the near future, it can operate this reaction function. This points to the benefit of a commitment to a transparent fiscal policy, which can be enhanced with the announcement and commitment to a multi-year public sector nominal budget balance, for example, in Thailand.

In equilibrium, however, as we shall see in the numerical example below, when fiscal policy is committed to respond fully in a forward looking manner to the fiscal stress shocks through public debt policy and to the cost-push shock through its tax policy, the central bank's interest rate reaction function will in effect be independent of all fiscal variables. It will only track equilibrium real interest rate r_t^*.

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[53] We may call the gap between the real interest rate and the equilibrium real interest rate "the real interest rate gap".

[54] By substituting the term $\sigma^{-1} y_t$ from one into the other.

[55] The last expression (in the bracket) implies that optimal interest rate responds also to the impact of the shocks that the fiscal authority fails to completely respond to, or over-respond to.

If we define a "fiscal dominance" regime as one under which nominal policy interest rate depends on fiscal variables such as the stock of public debt, then in equilibrium, we do not observe fiscal dominance at play in this regime. Indeed, the only way to completely stabilize the economy requires that interest rate is effectively independent of fiscal variables; that is, complete stabilization of inflation and the "output gap" requires full response from a committed and forward looking fiscal authority operating in a sophisticated debt market. Conversely, if for some reason the fiscal authority do not act appropriately, then interest rate will have to respond more to fiscal stress than it optimally should.

In the simpler case of fully flexible prices (the aggregate supply relation is vertical with infinite slope), pure fiscal stress shocks affecting the GSC are absorbed in full by rising or falling inflation with no effect on the "output gap". If society does not value low and stable inflation (i.e. inflation is dropped from the welfare loss function), then expected inflation will not be responded to, and it will be determined by the size of the shocks. If society has even a slight interest in seeing low and stable inflation (it care about the low inflation target), then bringing inflation down will require taxes or surplus (i.e. debt policy) to respond to stabilize inflation in the case of fully flexible prices.[56]

In the case of nominal rigidity, upon which we have been focusing our attention thus far, the aggregate supply relation will be of a positive finite slope and purely fiscal stress shocks will affect both inflation and the "output gap", i.e. inflation will not fully absorb the shocks to prevent output or taxes from having to change. For shocks of the same size, variation in the inflation rate will be smaller, the stickier the nominal prices (the smaller the slope of the aggregate supply relation). Evidence from Poonpatpibul, et al. (2004)[57] suggesting that prices in Thailand have become stickier after the 1997 crisis points to smaller effect on inflation and more effect on the "output gap", given the same slope in the GSC.[58]

In general, various shocks are likely to be part of the composite fiscal stress and cost-push disturbances, hence affecting both the short-run aggregate supply and the intertemporal GSC. Evaluating the effects of these shocks, particularly if they are persistent, require numerical simulation, which we elaborate further below.

[56] However, to stabilize both inflation and output gap completely in this case, public debt policy has to anticipate the fiscal correctly and counter it fully when it takes place.

[57] Paper to be presented at the Bank of Thailand Annual Symposium 2004.

[58] The smaller pass-through to inflation seems to be corroborated by evidence from other empirical models and the post-crisis experience with inflation. See Chensavasdichai and Buddharee (2003) for details.

4. Calibration and computational experiment

It must be emphasized that all models are, by nature, stylized and abstract. The usefulness of any theoretical model is in its application as a measuring device, much like a thermometer is in the physical sciences. By this definition, computation experiment is a useful tool since it is used to derive the quantitative implications of economic theory.

Much like a thermometer, the construction of which is based on the theory that mercury expands approximately linearly within a certain range of temperatures at a given air pressure, the model we use is based on well-tested economic theory. Logically, then, much like the need to calibrate a thermometer to read 0 degree Celsius when immersed in iced water and 100 degrees Celsius when immersed in boiling water, an economic model's parameters can be calibrated so that the abstract model mimics reality along some relevant dimensions and is ready for use. Also, much like the process of recalibrating a thermometer when used on Mount Everest as opposed to at sea level, the reliability of which is based on sound theory, the ability to recalibrate an economic model with reliability should not present a problem if the theory on which the model is built is rigorous and applicable across economies.

A quantitative model is considered useful if it provides a concrete answer to an interesting, well-posed question of narrow class. In this section, we perform a computational experiment to record the time path of relevant economic variables when policy makers are committed to the above optimal targeting criteria.

Our next step is to calibrate the model to Thailand's "stylized facts". This step is performed in order for us to be certain that the model gives an approximately correct answer to some questions with *known* answers, so that we may have some confidence in its application.[59]

4.1 Calibrating the model

The following "stylized facts" for Thailand's economy are organized from the empirical regularities along some dimension observed in the country over time.[60] These "stylized facts" will be used in the process of establishing a correspondence between the real world, as represented by the data, and the simple "stylized" model economy we intend to use as a measuring device.

In the process of this computational experiment, we first restrict the model by specifying from the empirical regularities of the degree of price stickiness, preference and technology parameters, the effective tax rate and other related public sector variables, the gross markup in the labor market. Finally, a computational experiment can then replicate the

[59] For a good reference on computation experiment as an econometric tool, see Kydland and Prescott (1994).
[60] There are several unfavorable elements that a calibration attempt has to confront in an economy that is not in a steady state like Thailand. We must assume for the purpose of simplicity that despite all the changes going on in the Thai economy in the past 40 years, there are certain elements or dimensions of the economy that are relatively unchanged. These features are then organized into our "stylized facts".

key "stylized" relations among model variables. Note that we intend to calibrate a quarterly model.

In order to obtain the degree of price stickiness $\kappa \equiv \frac{(1-\alpha\beta)(1-\alpha)}{\alpha}\frac{\left(\omega+\sigma^{-1}\right)}{(1+\theta\omega)}$, we need to find the deep structural parameters $\alpha, \beta, \sigma, \theta, \omega$.

Finding α or the fraction of prices that remain unchanged in any period (here, quarter), we first compute from the consumer price data reported by Thailand's Ministry of Commerce the length of time in quarters it takes for the price of an average product in the consumer basket to change, the amount which we denote *T*, and calculate $\alpha \equiv \exp\left(-T^{-1}\right)$. As elaborated in the data appendix, we find that during the post-crisis years, from January 2002 to May 2004, prices in the consumer basket change about 6.38 times per year or 1.5958 times per quarter (equivalently $T = 0.6266$ quarter), on a weighted average basis, giving $\alpha = 0.2028$.[61]

The (preference) parameter β is calibrated from the short-term equilibrium real interest rate, and we use the number Rotemberg and Woodford (1999) uses, which is $\beta = 0.99$, which is consistent with the quarterly short-term real interest rate of 0.0101 or 1.01 per cent per annum.[62]

Some of the following parameters we have much difficulties pinning down owing to lack of applicable and reliable micro-level datasets in Thailand. For those which are difficult to obtain, we generally use those reported in the real-business-cycle literature or from the sources we cite below. However, we run limited and quick robustness checks on most of these parameters and find that if we vary some of these parameters by roughly ±10 per cent, the numerical time paths of our model variables do not change in any significant manner.

We pick $\omega = 0.473$, following Benigno and Woodford (2003). This value is consistent with the labor share parameter $\phi = 0.6856$, and $\nu = 0.01$. According to Ahuja and Muenjak (2002), labor share of national income in Thailand is roughly between 0.6-0.7 on average, depending on the method used to assign the "ambiguous income" mostly from own-account workers and proprietors, so the number 0.6856 used is in a realistic range.

As for another preference parameter $\sigma \equiv \tilde{\sigma}\left(\overline{C}/\overline{Y}\right)$, we pick $\sigma = 6.3694$, which is consistent with a ratio of Thailand's private consumption to national product of 0.54, and

[61] We find that prices are more flexible in pre-crisis Thailand through lower *T*, and thus higher α, as reported in the appendix. Everything else equal, the pre-crisis short-run aggregate supply is more steep than it is today.

[62] We experimented with a range of numbers for β from 0.96-0.99, which corresponds to the quarterly equilibrium real interest rate of 1-4 per cent per annum, in reverse order. Since $1/\left(1+\bar{r}^*\right) = \beta \in (0,1)$, otherwise the equilibrium short-term real interest rate (or the discount rate) would be infinity or zero, we pick the one closest to 1 (and hence interest rate of 1.01 per cent) at this point to reflect the low financial rate of return on the 90-day government debt.

$\tilde{\sigma} = 11.7951$.[63] The steady-state gross markup parameter $\bar{\mu}^w$ is given to be 1.11, consistent with $\theta = 10$, since $\bar{\mu}^w \equiv (\theta/\theta - 1)$. In sum, this gives us the slope of the short-run aggregate supply curve, $\kappa = 0.3456$.

Next we use the time series from Thailand's GFS government sector dataset to calculate "steady-state" values for $\bar{\tau}, s_d \equiv (\bar{s}/\bar{Y}), s_G \equiv (\bar{G}/\bar{Y}), \omega_g \equiv (\bar{G} + \bar{\zeta})/\bar{Y}$, and $\bar{b}/\bar{Y}$ (see data, definitions and sources in the appendix). We find $\bar{\tau} = 0.22, s_d = 0.002, s_G = 0.19, \omega_g = 110$, and we set $\bar{b}/\bar{Y} = 2.4$, which since model's Y is quarterly output, the number 2.4 picked corresponds to the ratio of public debt to *annual* GDP of 0.6. We set the steady-state public debt level at 60 per cent of GDP for 2 reasons: (1) the real public debt to annual GDP ratio as of 2001, the last year for which we have published non-preliminary data, is 0.58 or 58 per cent and (2) the number 0.6 is the reasonable ceiling, which the EU countries agreed on at Maastricht.

The steady-state output growth rate, which is the same as that for the exogenous technology factor, consumption, government purchases of goods and services, and transfer, is given to be 0.0125 per quarter, roughly equal to 0.05 per year. This is a reasonable number considering Thailand's real GDP has been growing at roughly that rate on average during 1970-2003.[64]

Table 2.1: Model's deep structural and public-sector parameters

Preference and technology	Other parameters
$\alpha = 0.2028$	$\bar{\tau} = 0.22$
$\beta = 0.99$	$s_d = 0.002$
$\omega = 0.473$	$s_G = 0.19$
$\phi = 0.6856$	$\omega_g = 110$
$\sigma = 6.3694$	
$\theta = 10$	

Accordingly, $\Psi_1 = 0.129, \Psi_2 = 0.234$, and we obtain the optimal targeting criteria for the Thai economy as follows:

$$\begin{aligned} \pi_t + 0.129\pi_{t-1} + 0.234(y_t - y_{t-1}) &= 0, \\ E_t\pi_{t+1} &= 0, \end{aligned} \tag{4.1}$$

[63] The number 0.54 comes from the average ratio of private consumption to GDP ratio from 1997Q1-2004Q1. If we average only from 2003Q1-2004Q1, we get the ratio to be 0.54, a strikingly similar number, suggesting that Thailand may be on some kind of a narrowly defined steady state.

[64] The exact number does not matter to the result at all. It just gives us a more realistic display of business cycle results around the positively sloped long-term trend, the slope of which equals the growth rate of the exogenous technology factor. Such growth rate can be anything in the future and it does not depend on the stabilization goals we are discussing at length here.

What these target criteria suggest is that, *correctly measured*, near-term inflation target and the *projected* rate of change in the output gap (equivalently, the change in the size of output deviation from its potential) both be made zero or close to zero with different signs. In any case, for near-term inflation target to be positive (negative), the rate of change in the output gap has to be negative (positive), that is projected deviation of output from potential has to shrink over time, as they must sum to zero. In practice, with measurement errors in the consume price inflation that may have an upward bias, the said sum may have to be made equal to the estimated size of the bias.

4.2 A computational experiment

Since the calibrated model is constructed under an instruction from solid theory, we can use this measuring device to explore how optimal policy rules can work as guidance for macroeconomic policy makers going forward. Given that this experiment is purely an academic exercise, its usefulness is in giving us some valuable insight as to how optimal policy can be conducted given assumptions on the various specifications of shocks.[65] Here, we are concerned with persistent stochastic shocks to the Thai economy.[66]

We do not claim that Thailand in 2004 is on its long-run steady state or "balanced growth" path, but in using this model, we are assuming that the Thai economy is at least approximately not too far away from the "balanced growth" path, as earlier defined and justified from the long-term GDP growth data.

We also realize that in reality, no one, fiscal and monetary authorities included, has perfect foresight into an infinite horizon and, as a consequence, can plan to smooth out all future disturbances. To make it more realistic, we restrict the forward-looking ability of policy makers to 16 quarters (4 years).[67] Thus we are assuming that the central bank can forecast approximately correctly up to 16 quarters the government public debt and tax paths (surplus is the residual in this sense), while the fiscal authority can forecast approximately correctly the interest rate path and the paths of inflation and output (as targeted).[68] Moreover, both authorities can forecast reasonably well the exogenous shock processes that the economy will face up to 16 quarters ahead.

As for what optimal responses to various shocks and the business cycle outcomes may look like, we take as an example a likely case in the medium term in which government expenditure evolves according to the same estimated stochastic process that governs it during 1970-2003 from Thailand's data. Additionally, persistent technology and wage markup shocks also buffet the economy. By persistence, we mean technically that each of these variables follows a highly serially correlated but (covariance-) stationary process; that is, it would take some time for these variables to return to their long-term steady state values, should they deviate from them today.

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[65] For a simple case of temporary (one-quarter) purely fiscal stress shocks through "government transfer", see Benigno and Woodford (2003).

[66] Obviously, we exclude cases of *un*expected shocks, because by their very definition, they cannot be forecast.

[67] The more forward looking the policy makers are, the less fluctuation one can expect in the instrument paths, as complete stabilization with less planning horizon will result in more swift and therefore sharper responses.

[68] Hence the need for consultation, announcement and commitment to policy targets and instrument targets.

We assume the following:

(1) Deviation of government purchases as a share of the national product from its long-term steady state of 0.19, $\hat{G} \equiv \frac{G_t - \overline{G}}{\overline{Y}}$, follows an annual AR(1) stationary process that is consistent with one that may have generated $\hat{G}$ in the past (during 1970-2003).[69]

$$\hat{G}_t = 0.99\hat{G}_{t-1} + \eta_t, \text{ where } \eta_t \sim N(0,0.002).$$

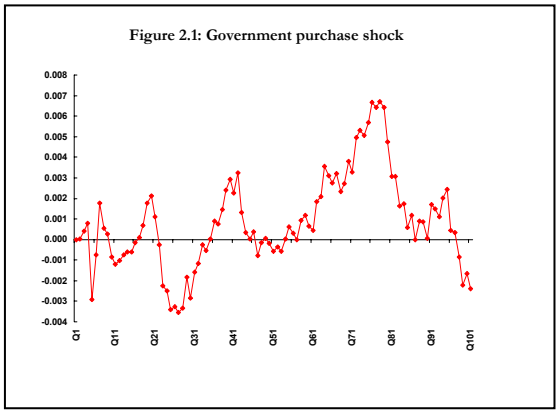
Fig. XXX shows possible quarterly values of this disturbance 86 quarters from today.

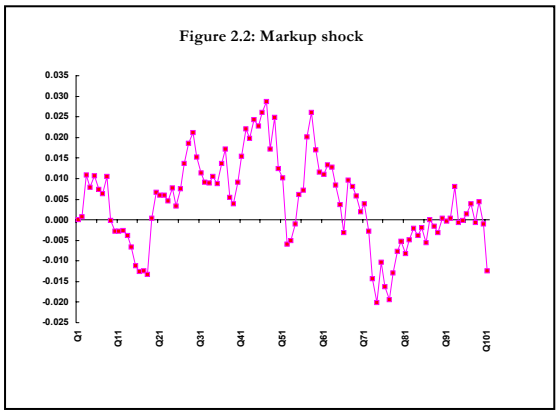
(2) Technology shock follows a highly persistent AR(1) stationary process, as is usually modeled in the real business cycle literature.[70] Its possible values are captured in Fig. XXX.

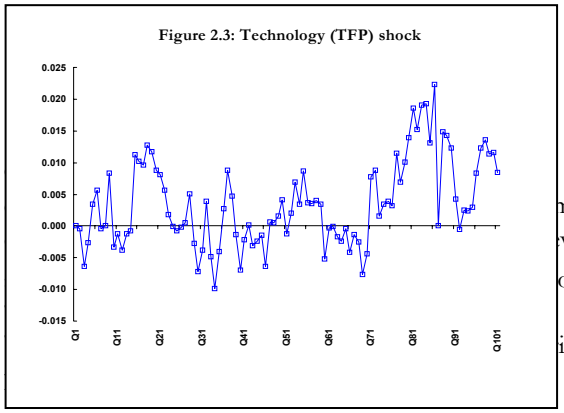
$$q_t = 0.9q_{t-1} + \upsilon_t, \text{ where } \upsilon_t \sim N(0,0.005).$$

(3) The gross markup in the labor market follows a highly persistent AR(1) stationary process,[71] and its time path is displayed in Fig. XXX:

$$\hat{\mu}_t^w = 0.9\hat{\mu}_{t-1}^w + \varsigma_t, \text{ where } \varsigma_t \sim N(0,0.005).$$







Given these 16-quarter-ahead *expected* disturbances, we have below optimal responses for policy makers that adhere to the

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the variable, then there must be high persistence in its
n the dataset given in the appendix, the standard deviation
viation from the steady state should have a zero mean and
of 0.0006, to which our assumption conforms roughly.

ing a business upturn the markup may be adjusted upward

above target criteria. Figures 2.1-2.9 display the optimal inflation rate, "output gap", and business cycle outcomes and the required target-consistent policy responses of short-term nominal interest rate, effective tax rate, public debt (and ultimately nominal surplus as a percentage of GDP).[72]

What we observe is that given these shocks and the structure of the economy, complete simultaneous stabilization of inflation and the "output gap" is possible. The main reason is that government borrowing *can adjust* from period 1 onward to counter the fiscal stress shocks that start to hit in period 2 in a forward-looking manner. We have complete price stability, which in practice translate into low and stable inflation, but the business cycle still exists, albeit very small. That is, the standard deviation of the business cycle (defined as percentage deviation of actual output from its long-term trend, not to be confused with the output gap, which we already stabilize to zero) is only 0.015 or 1.5 per cent.[73] The focus is that we have zero "output gap" and price stability, and the fluctuating business cycle around a balanced growth trend is simply a consequence of disturbances with which we have to live.

Optimal monetary policy action through interest rate is interestingly small, since the major fiscal stress shock (to aggregate demand) is neutralized by good planning (borrowing and repaying of loans) by the government and the ability to borrow in a sophisticated market. That is, optimal short-term policy interest rate varies narrowly between 0.75-1.34 per cent (recall that with no shocks interest rate stays at 1.01 per cent) around the mean of 1.01 per cent, tracking closely the real equilibrium interest rate that in turn tracks the deviation of potential output away from long-term trend. The effective tax rate *does* adjust, but barely, fluctuating from 21.35-22.44 per cent around the mean of 21.88 per cent (steady-state no-shock effective tax rate is calibrated to Thai data at 22 per cent). The tax rate adjusts to offset the cost-push shock that shifts the aggregate supply relation, since in this model of distortionary taxation, tax rates affect the real *marginal* costs of firms and thus aggregate supply. The adjustment in the effective tax rate implies that the government adjusts its revenue collection and grant somehow since it cannot vary tax rates so often in reality.

Monetary policy will have to act more forcefully when government borrowing is constrained or when the fiscal authority is not forward looking or refuses to commit to the target we consider the following case: If, for some reason, we *disallow* variation in government borrowing in the initial period 1, then optimal quarterly interest rate responses will show a larger jump upon the hit of the first shocks in period 2. This one-time large adjustment in interest rate (not shown here, but i_2 does not track r_2^* as closely as it should) owes to the fact that our period-1 borrowing level is conditioned to be at the initial steady-state level where debt-to-quarterly-GDP ratio is set at 2.4 and is not allowed to adjust to counter the first wave of fiscal stress that is anticipated in period 2 *in a forward-looking manner*, as it is supposed to do optimally. The result in this case is that we only have near but not complete stabilization in period 2.

[72] Recall that unexpected shocks are by definition *un*expected and should be equal to the realized value less its expected value. Our forward looking stabilization program is concerned only with the expected part, naturally.

[73] To get some perspective, Thailand's business cycle during 1970-2003 has percentage standard deviation of approximately 4.6%. We are not implying that had policymakers adopted these targeting rules, the business cycle outcome would see a drop in volatility from a standard deviation of 4.6% to 1% over 1970-2003, as the nature of the shocks buffeted the economy during the time may not be those assumed here.

What we also observe under optimal response is that monetary policy should take account of the requirements for government solvency.[74] In practice, this does *not* automatically imply that the central bank will have to increase its monetary base in order to act as a residual purchaser of government debt whenever the government runs a budget deficit. Economic theory implies that if anything, (1) the public's demand for government bond is not necessarily fixed over time, so that in the absence of a price or yield change, the central bank will not always have to acquire the additional issues—indeed, an increase in government borrowing may well increase the public's willingness to hold government bonds, even when bond yields do not change[75]; and (2) it is impossible to increase the monetary base (or public holdings of cash) by an arbitrary amount without any change in the relative yield on money and bonds.

The important factor that indicates the degree to which various economic disturbances can affect short-run projections for inflation or output gap, and therefore our targets, is the degree to which they create fiscal stress by shifting the GSC, and therefore aggregate demand (through changes in private sector budget constraints).

This example suggests a disciplined government (public sector) is required for our stabilization goals to succeed. By discipline, we do not mean the government must maintain zero deficit or surplus at all times, but that it runs only sufficient deficits and surpluses as required to offset shocks to aggregate demand (through fiscal stress), plan its financing well in advance and communicate with the central bank on a multi-year basis on its debt path—but not pressuring the central bank to accommodate its fiscal needs through seigniorage. This way, in the example above, we do not live under a fiscal dominance regime and nominal interest rate policy in effect depends only on changes in the potential output and inflation, in compliance with the target criteria.

Figure 2.4: Optimal policy interest rate response path

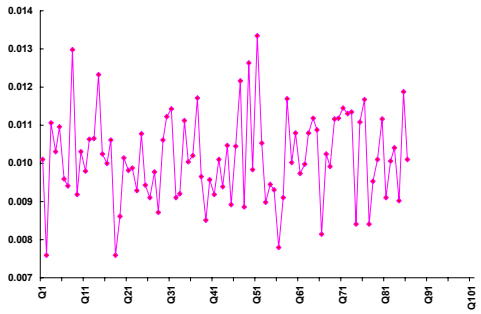


Figure 2.5: Optimal effective tax rate response path

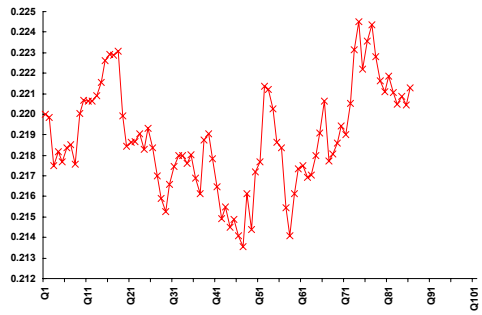


Figure 2.6: Optimal public-debt-to-quarterly-GDP ratio

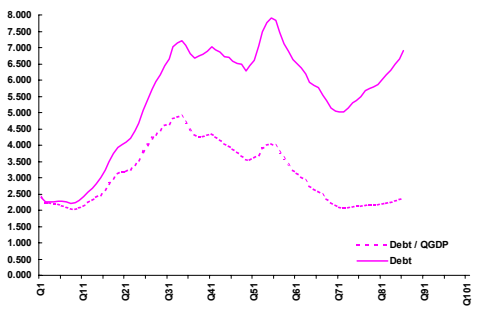
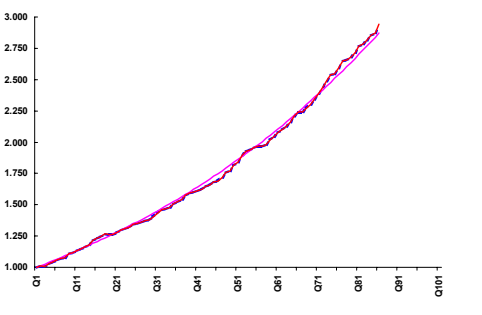


Figure 2.7: Actual output equals potential output around steady state



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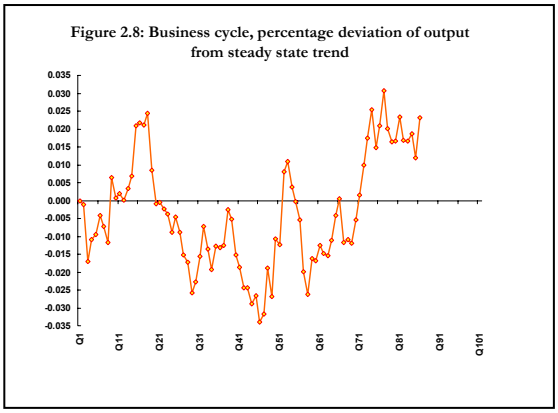

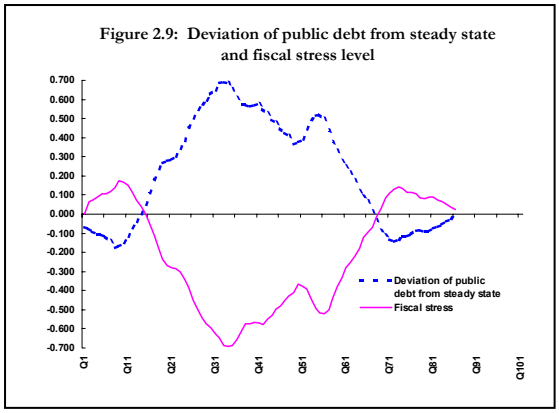

5. Conclusion and recommended agenda for future research

How fast Thailand's economy can grow over the long run depends on productivity growth, which takes the whole society to influence. For macroeconomic policymakers, the crucial task is to manage the *short-run* upturn in a manner that allows firms, farms and workforce to unleash their productive capacity efficiently. Monetary and fiscal policy should be forward looking in identifying risks, and *coordinate* to preserve economic stability going forward.

The central bank and the fiscal authority can most effectively achieve their stabilization goals if they act appropriately and the private sector widely understands those actions, so that they can respond in a certain predictable way. Having well-defined, transparent *rules* for systematic conduct of policies can enhance the clarity of purpose, the effectiveness of policy communication and ultimately of policy itself.

In retrospect, rules, broadly defined, are not foreign to Thai authorities. The central bank used to fix the exchange rate while the central government targets its budget balance on an annual basis. There is evidence to suggest that these policies were sometimes inconsistent.

We search for *optimal*, welfare-maximizing policy rules. Such rules involve explicit targets. Going forward, the optimal rules we advocate focus on achieving low near-term inflation with a minimum gap between near-term output and its potential. We view the fiscal side as *overall* government, including central, local, state enterprises and quasi-fiscal entities. We also obtain forward-looking rules for policy instruments, namely short-term interest rates and multi-year public-sector budget balances, that will ensure the jointly-agreed optimal targets be met, given any likely scenarios the economy may face.

Fundamentally, the optimal rules are made in recognition of the fact that both fiscal and monetary policy can affect the stabilization goal of price stability in a sticky-price world

where most of government revenue comes from distortionary taxation (in which taxes affect aggregate supply or marginal cost of firms). Having and committing to these targeting rules work to the advantage of the economy because the central bank and the fiscal authority will achieve their stabilization goals most effectively.

For the sake of effective policy communication to the private sector, we recommend that the central bank continue to announce publicly its commitment to its target and keep its (target-consistent) instrument's reaction function for use in internal policy debate or guidance. There is no need to announce the interest rate path formally far into the future, if the central bank can convince the public of its commitment to the target. In this matter, track record is most important and the Bank of Thailand must be in a continual process of building one.

The government, on the other hand, may choose to commit to a pre-announced instrument path, in particular, the nominal primary public sector budget balance on a multi-year basis. This would imply a planned announcement of a multi-year debt path that aims for stabilization of inflation as well as output gap. We recommend that the government announce *and* commit to a path for its instrument in the near term because this is of similar nature of the target that the government normally announces (albeit only for central government budget balance and on one-fiscal-year basis in the case of Thailand) and the public is already familiar with its surplus or deficit target. This not only would enhance the effectiveness of private expectations management, it would also enable the central bank to anticipate correctly future government action to ensure that its commitment to the target can be honored.

The framework and the calibrated model in this paper have potential for applications in addressing current issues of public concern as well, such as the privatization drive of state-owned enterprises (counted in the public sector) or large government expenditure planned for infrastructure projects, among other things. Because the model does not distinguish between central and local government action, treating similarly these agencies and other quasi-fiscal polices and state-enterprises as part of the public sector, the model does not have direct implications on the devolution of central government revenue to local governments that is planned to take place in the near future. Theory suggests that it does not matter if local government can take on debt or it has to be fully guaranteed by the central government to do so, as long as it is public sector debt, it should be treated in a similar fashion. This applies to quasi-fiscal policies as well.

Currently, even though the measurement device used is a closed-economy model, there is also potential for analysis for the open-economy case. Thus, in addition to these interesting and important public policy questions, the model used should be extended to the open economy case, so that effects from external shocks can be more robustly analyzed and possible exchange rate paths can be studied in details. Another potential area on which one can develop is in allowing for long-term public-sector borrowing and foreign currency debt financing.[76] Another area of potential is in developing and understanding optimal responses

[76] Indeed, one can rather quickly extend the model and the analysis to include foreign-currency denominated debt and long-term domestic debt for some specification of maturity structure, namely a geometric maturity structure.

to shocks if we have a richer (explicit) investment, saving and capital dynamics (that under the present model is subsumed under the exogenous technology factor).

Perfect fine-tuning rests only in theory, but the arguments in this paper offer ideas on how to coordinate policy to achieve a well-defined stabilization goals to maximize social welfare.

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Appendix A: Data used in this paper.

Table A.1: Income shares by income quintile and Gini coefficients for Thailand.

Year	Gini	Year	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Year	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
1962	41.28	1962	0.0800	0.1660	0.2868	0.5022	1962	0.0800	0.0860	0.1208	0.2154	0.4978
1969	42.63	1969	0.0513	0.1524	0.2956	0.4993	1969	0.0513	0.1011	0.1432	0.2037	0.5007
1975	41.74	1975	0.0492	0.1501	0.2980	0.5161	1975	0.0492	0.1009	0.1479	0.2181	0.4839
1981	43.10	1981	0.0430	0.1370	0.2760	0.4890	1981	0.0430	0.0940	0.1390	0.2130	0.5110
1986	47.40	1986	0.0420	0.1290	0.2600	0.4690	1986	0.0420	0.0870	0.1310	0.2090	0.5310
1988	47.40	1988	0.0410	0.1260	0.2540	0.4580	1988	0.0410	0.0850	0.1280	0.2040	0.5420
1990	48.80	1990	0.0400	0.1230	0.2480	0.4480	1990	0.0400	0.0830	0.1250	0.2000	0.5520
1992	51.50	1992	0.0370	0.1130	0.2290	0.4150	1992	0.0370	0.0760	0.1160	0.1860	0.5850
1994	52.09	1994	0.0404	0.1137	0.2305	0.4277	1994	0.0404	0.0733	0.1168	0.1972	0.5723
1996	51.58	1996	0.0412	0.1159	0.2335	0.4328	1996	0.0412	0.0747	0.1176	0.1993	0.5672
1998	50.90	1998	0.0424	0.1191	0.2384	0.4368	1998	0.0424	0.0767	0.1193	0.1984	0.5632
2000	52.49	2000	0.0388	0.1106	0.2248	0.4237	2000	0.0388	0.0718	0.1142	0.1989	0.5763
2002	51.03	2002	0.0417	0.1180	0.2376	0.4381	2002	0.0417	0.0763	0.1196	0.2005	0.5619

Note: Cols. 4-7 show cumulative income share by quintile, while cols. 9-12 show income share in individual quintiles.

Table A.2: REER, Real Interbank Rate, MCI and Real Credits

	REER (trade weighted)	Real Interbank rate (%)	MCI	% Change in MCI	MCI Cycle	Real credits (billion Baht)
1971						
1972						
1973						
1974						
1975						
1976						184.25
1977						218.67
1978						262.97
1979						293.25
1980	121.14	-5.11	101.53		-7.83	269.11
1981	123.79	4.51	108.99	7.09	-0.70	282.43
1982	125.68	9.62	113.10	3.70	3.12	317.37
1983	129.35	8.43	113.42	0.28	3.69	416.18
1984	143.07	12.67	120.60	6.14	10.32	481.21
1985	114.28	11.22	110.67	-8.59	2.47	521.78
1986	105.03	6.23	104.36	-5.87	-2.50	533.77
1987	100.25	3.43	100.95	-3.33	-4.89	638.37
1988	97.91	4.80	101.17	0.22	-3.78	796.15
1989	99.87	5.24	102.08	0.90	-2.07	992.30
1990	100.74	6.98	103.55	1.43	0.09	1262.29
1991	101.05	5.44	102.58	-0.94	-0.18	1438.28
1992	99.21	2.79	100.18	-2.37	-1.92	1664.28
1993	99.11	3.23	100.45	0.27	-1.05	1998.36
1994	100.00	2.17	100.00	-0.45	-0.89	2477.19
1995	99.70	5.18	101.98	1.96	1.72	2898.50
1996	104.74	3.38	102.30	0.31	2.79	3138.95
1997	96.46	10.10	104.37	2.00	5.68	3633.22
1998	83.66	4.90	96.82	-7.51	-0.81	3109.38
1999	86.80	1.44	95.40	-1.47	-1.16	2932.97
2000	83.36	0.40	93.62	-1.89	-1.89	2425.60
2001	79.49	0.32	92.37	-1.35	-2.06	2138.50
2002	81.70	1.14	93.62	1.35	0.46	2480.38
2003	80.42	-0.49	92.10	-1.64	0.00	2602.47

Source. Bank of Thailand

Note:

1) Real effective exchange rate (REER) series in this paper is the trade-weighted REER that is available on the Bank of Thailand's website. The based year is 1994.

2) Real interbank rate = average interbank rate minus inflation rate. This series is also available on the Bank of Thailand's website.

3) MCI (P_t) = [0.69 (i_t-i_{1994}) + 0.31 ($REER_t$-$REER_{1994}$)] + 100 ; t = 1970-2003

4) % change in MCI = ln(MCI_t)-ln(MCI_{t-1}) ; t = 1970-2003

5) MCI Cycle = ln(MCI_t) – ln(Hp-trend of MCI_t) ; t = 1970-2003

6) Real credits = private credits/CPI

Table A.3: Central Government Expenditure and Fiscal Balance

(Million Baht)

	Total Expenditure	Current Expenditure	Capital Expenditure	Overall Balance	Primary Balance
1971					
1972	28,316	20,204	8,112	-7,092	-4,876
1973	32,676	25,528	7,148	-7,041	-4,228
1974	34,958	27,770	7,188	2,489	5,660
1975	44,253	34,978	9,275	-6,236	-2,517
1976	55,254	40,824	14,430	-13,823	-10,261
1977	64,163	47,162	17,001	-13,082	-8,886
1978	80,137	59,581	20,556	-17,700	-12,379
1979	95,856	74,637	21,219	-20,400	-13,002
1980	124,551	95,685	28,866	-32,150	-22,469
1981	144,693	112,329	32,364	-25,505	-11,653
1982	169,785	131,449	38,336	-53,537	-36,923
1983	180,249	144,214	36,035	-36,408	-14,096
1984	191,203	157,326	33,877	-33,728	-8,977
1985	216,969	175,376	41,593	-55,403	-24,674
1986	220,979	180,923	40,056	-47,914	-12,946
1987	227,248	190,032	37,216	-28,983	7,926
1988	236,195	200,345	35,850	10,643	50,805
1989	266,337	227,792	38,545	54,732	98,830
1990	307,426	251,323	56,103	99,360	139,571
1991	364,019	285,108	78,911	118,414	153,731
1992	425,422	316,328	109,094	80,163	109,799
1993	504,630	353,267	151,363	66,363	91,576
1994	591,452	400,460	190,992	67,418	88,750
1995	660,702	432,580	228,122	123,061	137,066
1996	757,961	485,261	272,700	108,209	118,359
1997	957,707	530,647	427,060	-97,947	-82,579
1998	1,051,670	532,628	519,039	-356,485	-347,799
1999	1,160,241	596,499	563,742	-482,102	-437,372
2000	885,522	656,853	227,943	-149,100	-90,835
2001	1,012,537	788,250	224,743	-142,686	-78,966
2002	1,326,594			-396,753	-328,526
2003	1,056,857				

Source Government Financial Statistics (GFS)

Table A. 4: Real structural primary balance of consolidated central government

	Total Revenue	Total Expenditure	Interest payment	Buoyancy	Real Cyclical budget balance (% of GDP)	Real Structural Budget Balance (% of GDP)
1972	21.15	29.20	2.22	1.08	-0.8	-17.3
1973	25.43	33.44	2.81	1.08	0.3	-14.1
1974	36.97	35.30	3.17	1.08	-0.6	11.3
1975	38.07	45.11	3.72	1.08	-2.4	-4.4
1976	42.18	56.79	3.56	1.08	-1.3	-20.6
1977	51.56	65.28	4.20	1.08	1.4	-19.3
1978	62.21	81.01	5.32	1.08	5.0	-28.3
1979	75.39	97.22	7.40	1.08	5.0	-27.9
1980	94.95	129.04	9.68	1.08	3.1	-37.7
1981	113.85	143.06	13.85	1.08	1.8	-21.8
1982	118.31	174.46	16.61	1.08	0.0	-48.4
1983	143.20	182.58	22.31	1.08	-2.4	-17.7
1984	153.52	191.16	24.75	1.08	-5.2	-9.7
1985	163.07	222.25	30.73	1.08	-10.5	-21.7
1986	172.35	225.72	34.97	1.08	-16.3	-4.2
1987	197.02	232.87	36.91	1.16	-18.6	19.7
1988	251.47	246.64	40.16	1.16	-11.6	57.2
1989	317.13	268.75	44.10	1.16	-1.8	90.1
1990	404.56	311.80	40.21	1.16	8.3	111.7
1991	480.12	366.72	35.32	1.16	12.6	114.3
1992	508.06	431.37	29.64	1.16	13.9	72.7
1993	569.31	506.56	25.21	1.16	19.3	49.9
1994	667.41	603.85	21.33	1.16	31.7	32.1
1995	779.42	660.13	14.01	1.16	60.2	34.8
1996	872.97	767.90	10.15	1.16	72.7	6.0
1997	870.42	971.37	15.37	1.27	56.3	-112.9
1998	753.35	1,114.32	8.69	1.27	-32.8	-178.9
1999	740.25	1,225.25	44.73	1.27	-47.6	-222.5
2000	789.52	942.23	58.27	1.27	-36.2	-21.8
2001	909.78	1,044.36	63.72	1.27	-45.4	3.0
2002	958.66	1,318.65	68.23	1.27	-38.3	-135.8
2003	1,204.95	1,012.10	65.70	1.27	-21.8	173.1

Source. Government Financial Statistic Year Book Manual 1986 framework,

Note. Col.4-6 show author's estimation

Total Revenue used is Total revenue excluding grants

Total Expenditure used includes Total expenditure + Lending – Repayment

Table A.4: Public Sector Data

	Total Revenue	Total Expenditure (adjusted)	Transfers	Public debt	Interest payment
1982	136.7	200.30	13.978	310.58	18.78
1983	162.6	213.60	13.179	336.80	22.28
1984	186.6	230.50	9.699	380.35	26.76
1985	195.6	258.80	14.211	497.47	30.52
1986	213.5	264.90	12.502	572.43	35.96
1987	246.3	265.70	14.892	647.88	36.70
1988	308.7	292.50	15.386	636.47	40.06
1989	388	314.80	21.569	606.38	44.42
1990	490.7	395.10	23.989	593.78	39.97
1991	566.6	470.00	31.894	610.63	32.17
1992	607.9	564.00	28.665	615.25	28.60
1993	671.9	638.80	42.835	630.31	25.20
1994	795.4	725.90	43.22	697.57	20.67
1995	948.6	832.50	55.204	680.35	14.24
1996	1065.4	934.40	61.927	607.60	9.43
1997	1033.3	1,204.20	122.618	775.57	12.86
1998	914.9	1,348.90	272.952	1,047.81	18.98
1999	905.7	1,449.50	373.92	2,469.20	48.62
2000	953.4	1,185.40	105.36	2,804.30	55.64
2001	1094.8	1,224.60	200.904	2,931.70	60.23

Source. Col. 1-3 from Table 38: Non-financial Public Sector Operations, Data Management Group, Bank of Thailand

Col.4 from Government Financial Statistic Year Book (Manual 1986)

Col.5 from Public Debt: Monetary Policy Group and Public Debt Management Office

Col. 6 from NESDB: Distribution of National Income

Table A.5: Model's parameters calibrated from the following dataset

	τ	s_d	s_G	ω_g	ζ	b/y
1982	0.17	-0.055	0.204	-4.05	0.02	0.34
1983	0.18	-0.032	0.198	-6.66	0.01	0.38
1984	0.19	-0.018	0.200	-11.89	0.01	0.37
1985	0.19	-0.031	0.206	-6.99	0.01	0.39
1986	0.19	-0.014	0.194	-14.83	0.01	0.48
1987	0.20	0.014	0.170	13.24	0.01	0.51
1988	0.21	0.038	0.159	4.49	0.01	0.51
1989	0.22	0.066	0.140	2.30	0.01	0.43
1990	0.23	0.064	0.158	2.62	0.01	0.34
1991	0.23	0.053	0.167	3.40	0.01	0.28
1992	0.22	0.026	0.184	7.38	0.01	0.25
1993	0.22	0.019	0.185	10.53	0.01	0.22
1994	0.23	0.026	0.189	7.82	0.01	0.20
1995	0.23	0.032	0.188	6.28	0.01	0.20
1996	0.24	0.031	0.191	6.59	0.01	0.17
1997	0.22	-0.034	0.227	-7.54	0.03	0.13
1998	0.20	-0.089	0.226	-3.20	0.06	0.17
1999	0.20	-0.107	0.223	-2.83	0.08	0.22
2000	0.20	-0.036	0.211	-6.41	0.02	0.54
2001	0.21	-0.014	0.189	-16.74	0.04	0.58

Note: Col. 1-6 show Authors' calculation based on data from the Government Financial Statistic Year Book (Manual 1986)

1. $\bar{\tau} = \dfrac{\text{Total revenue}}{GDP}$, where Total revenue = Tax + Non-tax revenue+ Grants
2. s_d or Primary Balance/GDP in steady state, where
Primary Balance = Total Revenue - (Total Expenditure-Interest Payment)
3. s_G or Real government purchase/GDP, where
Real government Purchases = Real Total Expenditure – Real Transfer to Private Sector – Real Interest Payment
4. ω_g = (Real Total Expenditure – Real Interest Payment)/Real GDP
5. b/y = Public Debt/Real GDP
6. ζ = Transfer to Private sector/GDP, where
Transfer to Private sector= Total transfer- Transfer to other government level & Non-financial State Enterprises

Table A.6: Frequency of Thailand's consumer price changes in weight, as percentage of total consumer price basket

Frequency of price changes	1995-1997	2002-2004
No change	0.8186	8.2016
Every month	32.4115	18.3266
Every 2 months	2.4353	23.8845
Every 3 months	5.8877	2.4985
Every 4 months	21.0664	1.5699
Every 5 months	2.3749	1.0593
Every 6 months	6.3291	0.5020
Every 7 months	4.7801	0.1692
Every 8 months	6.5901	1.1308
Every 9 months	3.3235	2.6845
Every 10 months	6.5630	2.4451
Every 11 months	0.9670	3.3894
Every 12 months	2.4069	30.9735
More than 12 months	4.0460	3.1651

Appendix B: Definitions of model's disturbances and parameters

The composite cost-push shock: $u_t = u'_\xi \xi_t \equiv \hat{Y}_t^* + c'_\xi \xi_t$, where $u'_\xi \equiv \langle u_{\xi 1} \quad u_{\xi 2} \quad u_{\xi 3} \quad u_{\xi 4} \quad u_{\xi 5} \rangle$ such that,

$$u_{\xi 1} \equiv \frac{\Phi \omega_\tau}{q_y \Gamma} s_d^{-1} \sigma^{-1},$$

$$u_{\xi 2} \equiv \frac{\Phi \sigma^{-1} s_d^{-1} \omega_\tau}{q_y \Gamma} - \frac{\sigma^{-1} s_C^{-1} \Phi (1 + \omega_g + \omega_\tau)}{q_y \Gamma},$$

$$u_{\xi 3} \equiv -\Phi \sigma^{-2} \frac{(1+\omega_\tau)(1+\omega_g)}{q_y \Gamma (\omega + \sigma^{-1})} + \Phi \sigma^{-2} s_C^{-1} \frac{1 + \omega_g + \omega_\tau}{q_y \Gamma (\omega + \sigma^{-1})},$$

$$u_{\xi 4} \equiv \omega \sigma u_{\xi 3},$$

$$u_{\xi 5} = -\sigma u_{\xi 3} + \frac{(1-\Phi)}{q_y}.$$

The composite "fiscal stress" disturbance term: $f_t \equiv h'_\xi \xi_t + (1-\beta) E_t \sum_{T=t}^{\infty} \beta^{T-t} f'_\xi \xi_T$, where $h'_\xi \equiv \langle h_{\xi 1} \quad h_{\xi 2} \quad h_{\xi 3} \quad h_{\xi 4} \quad h_{\xi 5} \rangle$ and $f'_\xi \equiv \langle f_{\xi 1} \quad f_{\xi 2} \quad f_{\xi 3} \quad f_{\xi 4} \quad f_{\xi 5} \rangle$ such that

$$h_{\xi 1} \equiv -\frac{\Phi \omega_\tau}{q_y \Gamma} \frac{\sigma^{-2}}{s_d},$$

$$f_{\xi 1} \equiv \frac{\Phi}{q_y} \frac{\sigma^{-1}}{s_d} + \frac{1}{s_d},$$

$$h_{\xi 2} \equiv \frac{\Phi \sigma^{-2} s_d^{-1} \omega_\tau}{\Gamma q_y} + \frac{\sigma^{-2} s_C^{-1} \Phi (1 + \omega_g + \omega_\tau)}{\Gamma q_y},$$

$$f_{\xi 2} \equiv \frac{\Phi \sigma^{-1} s_d^{-1}}{q_y} - \frac{\omega_\tau^{-1} \sigma^{-2} s_C^{-1} \Phi (1 + \omega_g + \omega_\tau)}{\omega_\tau q_y} + \frac{1}{s_d},$$

$$h_{\xi 3} \equiv \Phi\,\sigma^{-2}\,\frac{(1+\omega_\tau)(1+\omega_g)}{q_y\Gamma} - \Phi\,\sigma^{-2}s_C^{-1}\,\frac{1+\omega_g+\omega_\tau}{q_y\Gamma} + \frac{(1-\Phi)\omega\sigma^{-1}}{q_y} + \frac{\omega\sigma^{-1}\Phi(1+\omega)(1+\omega_g)}{\Gamma q_y},$$

$$f_{\xi 3} \equiv \frac{\omega_\tau^{-1}\Gamma(1-\Phi)\sigma^{-1}}{q_y} + \frac{\omega_\tau^{-1}\sigma^{-1}\Phi(1+\omega)(1+\omega_g)}{q_y} - \sigma^{-1}(1+\omega_\tau^{-1})(1+\omega_g),$$

$$h_{\xi 4} \equiv -\frac{\sigma^{-1}(1-\Phi)\omega}{q_y} - \frac{\sigma^{-1}\omega\Phi(1+\omega)(1+\omega_g)}{\Gamma q_y},$$

$$f_{\xi 4} \equiv \frac{\omega_\tau^{-1}\Gamma(1-\Phi)\omega}{q_y} + \frac{\omega_\tau^{-1}\omega\Phi(1+\omega)(1+\omega_g)}{q_y} - \omega\omega_\tau^{-1}(1+\omega_g),$$

$$h_{\xi 5} \equiv \sigma^{-1}\Phi\frac{(1+\omega_g)(1+\omega)}{q_y\Gamma},$$

$$f_{\xi 5} \equiv -\omega_\tau^{-1}\Phi\frac{(1+\omega_g)(1+\omega)}{q_y} + \omega_\tau^{-1}(1+\omega_g).$$

Definitions of the coefficients $\Omega_1 - \Omega_6$,

$$\Omega_1 \equiv \frac{\widetilde{m}_b}{\widetilde{m}_b + \Omega_3},$$

$$\Omega_2 \equiv \frac{1}{\widetilde{m}_b + \Omega_3},$$

$$\Omega_3 \equiv b_\tau(\Psi^{-1} - 1)(\Omega_5 + \Omega_6),$$

$$\Omega_4 \equiv -q_\pi^{-1}(\kappa^{-1}(1-\beta)b_t\Psi^{-1} + 1),$$

$$\Omega_5 \equiv -q_y^{-1}\Psi^{-1}(1-\beta)b_\tau + q_y^{-1}\left[(1-\beta)b_y + \sigma^{-1}\right],$$

$$\Omega_6 \equiv -q_y^{-1}\sigma^{-1}, \text{ where}$$

$$\widetilde{m}_b \equiv \sigma^{-1}\Omega_6 + \Omega_4 - (1-\beta)\left[b_t\Psi^{-1} - b_y\right]\Omega_6 + (1-\beta)\Psi^{-1}\kappa^{-1}b_\tau\Omega_4,$$

$$q_y \equiv (1-\Phi)(\omega+\sigma^{-1}) + \Phi(\omega+\sigma^{-1})\frac{(1+\omega_g)(1+\omega_\tau)}{\Gamma} + \Phi\sigma^{-1}\frac{(1+\omega_g)(1+\omega_\tau)}{\Gamma} - \Phi\sigma^{-1}(1-s_G)^{-1}\frac{1+\omega_g+\omega_\tau}{\Gamma},$$

$$q_\pi \equiv \frac{\Phi\theta(1+\omega)(1+\omega_g)(\omega+\sigma^{-1})}{\Gamma\kappa} + \frac{\theta(1-\Phi)(\omega+\sigma^{-1})}{\kappa},$$

and $b_\tau \equiv \bar{\tau}/(1-\bar{\tau})$.