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Much Ado About Nothing? Estimating the Impact of a U.S. Slowdown on Thai Growth

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Much Ado About Nothing? Estimating the Impact of a U.S. Slowdown on Thai Growth

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Abstract

External demand was the main driver of growth in Thailand in 2006 and 2007. However, WEO projections indicate moderating foreign demand in 2008, with U.S. growth being revised downwards to reflect the turmoil in housing and credit markets, and high oil prices. While the share of Thai exports to the US has fallen in recent years, the US remains Thailand's largest export destination. We use a small structural model and Bayesian estimation to assess the possible impact of a U.S. slowdown on Thai growth. We find that a 1 percent slowdown in U.S. growth in 2008—relative to the baseline forecast—could have an upper-bound impact on Thai GDP growth of 0.9 percentage points.

JEL Classification Numbers: F41; F42

Keywords: Growth; U.S. Slowdown; Bayesian Estimation; Thailand

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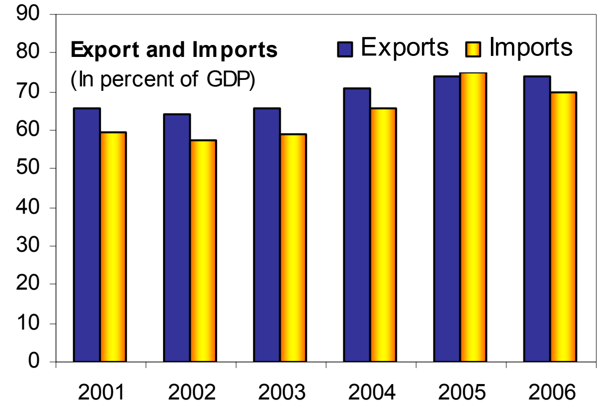
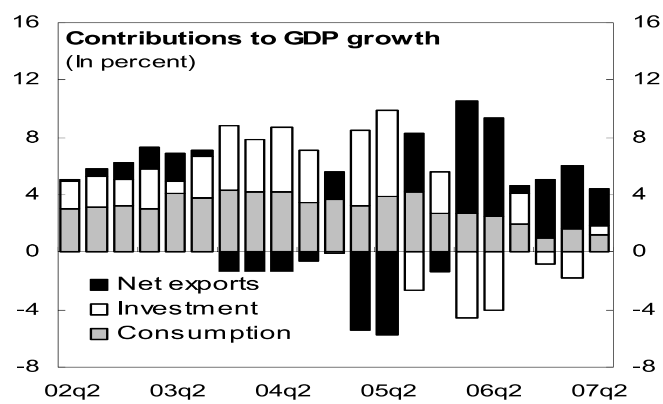
Contents Page

I. Introduction

1. **Thailand is a very open economy, and as such, its domestic fortunes are strongly linked to external demand conditions.** The share of trade in GDP has been increasing steadily over time, and stood at over 140 percent in 2006. Exports of goods and services accounted for about 74 percent of GDP. Moreover, over the last two years, Thai growth has been driven to a very large extent by net exports. The unsettled political situation and some market-unfriendly policy measures have weakened domestic demand, with the contribution of domestic investment to growth being negative for four out of six quarters since the beginning of 2006. The strong performance of net exports has therefore been the engine of growth.



2. **Net exports have performed exceptionally well over the last two years.** Partly, this is because depressed domestic demand has led to a fall in imports. Imports grew at an anemic 7 percent in 2006 and 6.4 percent in 2007 (H1), after registering average growth of about 14 percent over the previous five years. But it is also because of surging exports, which grew at 17.4 percent and 18.4 percent in 2006 and 2007 (H1) respectively, after registering average growth of about 10.5 percent over the previous five years.



3. **In these circumstances, any slowdown in external demand could have a potentially strong impact on the Thai economy.** Thailand's most important export market is the US, accounting for 15 percent of Thai exports in 2006. Moreover, the correlation between U.S. growth and Thai exports, and between U.S. growth and Thai growth, has been positive over a long time period.[2]

[2] Is there evidence of "decoupling"? Different data suggest different answers. On the one hand, the U.S. share of Thai exports has been declining steadily over time, with the trade shares of China, the Middle East, and other Asian countries rising. On the other hand, looking at the three preceding U.S. recessions—in 1990–91, 1995, and 2001—it is evident that the largest impact on Thai growth and exports was in 2001. This is because the magnitude of the U.S. slowdown in 2001 was much larger than the earlier episodes, and because the collapse of the information technology bubble led to a sharp

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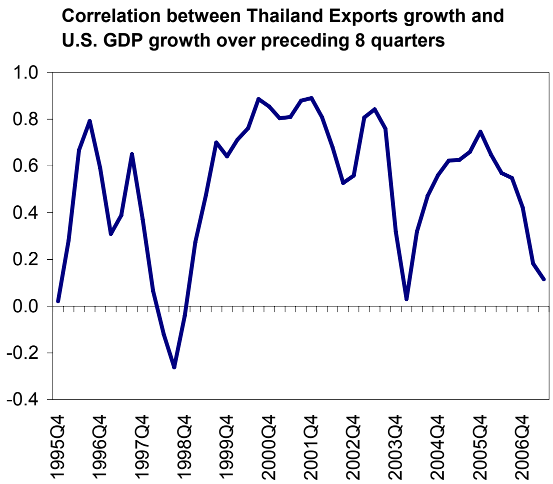
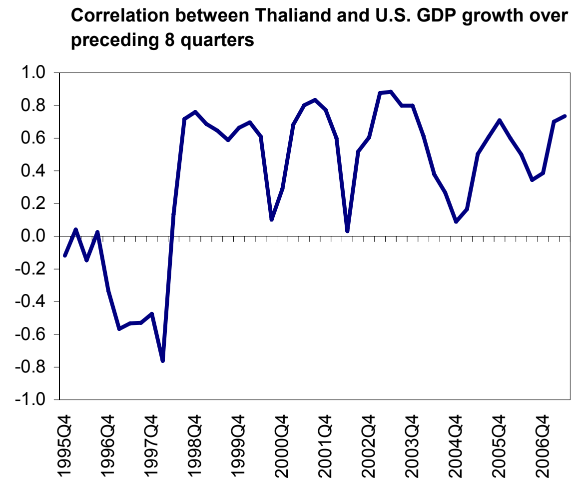
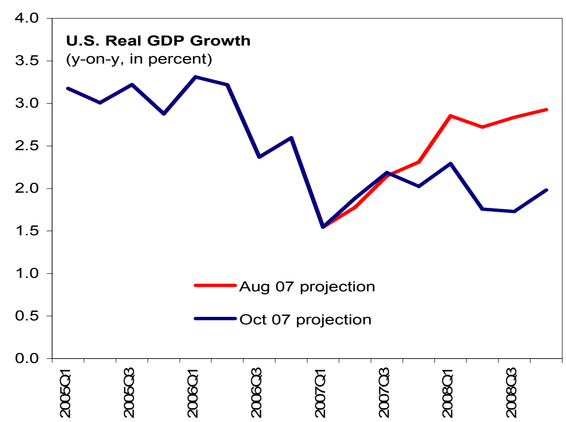




4. **There is a strong consensus that the US is headed toward a slowdown in economic growth, which may be exacerbated by the recent woes in the subprime mortgage market, in housing and credit markets more broadly, and by high oil prices**. WEO forecasts suggest that growth in 2007 will fall to 1.9 percent from 2.9 percent the previous year, and remain at that depressed level in 2008. Moreover, forecasts of the U.S. economy have been getting more pessimistic over time, as illustrated by a comparison of August and October WEO projections.



5. **The combination of a Thai economy in which net exports are the main engine of growth, and a slowdown in Thailand's largest trade partner presents an obvious challenge for the country.** This paper contributes to the analysis of that challenge by estimating the impact of the projected U.S. slowdown on Thailand's economy in the context of a small general equilibrium model. We examine the response of a deviation in U.S. growth from the WEO baseline on Thai inflation, growth, exchange rates, and interest rates. We also examine the implications of the speed of the monetary policy response to the external demand shock. Bayesian estimation is used to parameterize the model, thereby allowing a balance of historical data and expert judgment to decide parameter values; we hope that this will be conducive to a more constructive policy dialogue.

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decline in imports of information processing equipment, in which Thailand (along with other Asian countries) has been increasingly specializing. Thus both the magnitude and the sectoral composition of a future U.S. slowdown would be relevant to the impact on Thailand.

6. **The paper is organized as follows.** Section B introduces the model we use and our priors for various parameters. Section C briefly describes the estimation technique. Section D details our main results. Section E provides some confidence intervals for our analysis. The next section concludes.

II. THE MODEL

7. **The analysis is conducted using a small New Keynesian macroeconomic model with rational expectations, adapted from the framework developed by Berg, Karam and Laxton (2006).** It blends the New Keynesian emphasis on nominal and real rigidities with the real business cycle tradition of dynamic stochastic general equilibrium modeling with rational expectations. Although such models can be derived explicitly from microeconomic foundations, in our framework, we employ only four structural macroeconomic equations, each of which is specified in a sufficiently general form to allow adaptive as well as rational expectations, and substantial inertia. While the equations contain several parameters of policy interest and generate detailed forecasts of important economic variables, the relatively small size of the model means that the process by which a particular set of parameters leads to a particular set of forecasts is transparent (compared, e.g., to the IMF's Global Economic Model)[3] Such models are at the center of policy-making analysis in many central banks in the world.

8. **The model consists of two main sets of equations: the first describes the small Thailand economy, and the other, the US:**

Output gap equation

Domestic output depends on the real interest rate, the real exchange rate, and demand in the rest of the world, represented by the US. Dynamics are added through past and future domestic output gaps:

$$ygap_t = \beta_1 ygap_{t-1} + \beta_2 ygap_{t+1} - \beta_3 (RR_{t-1} - RR^*_{t-1}) + \beta_4 (z_{t-1} - z^*_{t-1}) + \beta_5 yusgap^*_t + \varepsilon^y_t$$

where *ygap* is the output gap, *RR* is the real interest rate, *z* (in logs) is the real exchange rate (measured so that an increase is a depreciation), and a '*' denotes an equilibrium value of a variable. The output gap is measured as the deviation, in percentage points, of actual output from a measure of the trend or equilibrium level of GDP (a positive number indicates that output is above trend). Finally, *yusgap* is a similarly measured output gap in the U.S. economy, included to capture spillover effects from U.S. demand to Thailand exports.

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[3] See Berg, Karam and Laxton (2006) for further discussion of the philosophical underpinnings of the framework employed here.

Phillips curve

Inflation depends on expected and lagged inflation, the output gap, and the exchange rate gap:

$$\pi_t = \delta_1 \pi^4_{t+4} + (1-\delta_1)\pi^4_{t-1} + \delta_2 ygap_{t-1} + \delta_3 (z_t - z_{t-1}) + \varepsilon^{\pi}_t$$

where π^4_{t-1} is inflation over the last four quarters (four-quarter change in the CPI), and π^4_{t+4} is the expected rate of inflation over the next four quarters. The lag term captures intrinsic inertia in the adjustment coming from sources other than expectations, such as adjustment costs or contracts.

Exchange rate equation

The exchange rate equation (in logs) imposes relative purchasing power or interest parity (IP), an arbitrage condition that says that real interest rates (on investments in different currencies) will be equalized across countries. A real exchange rate definition is used to write the conventional IP condition as a real IP condition as follows:

$$z_t = z^e_{t+1} - (RR_t - RR^{US}_t)/4 + \varepsilon^z_t$$

where RR^{US}_t is the U.S. real interest rate. As before, RR_t is the real policy interest rate and z_t is the real exchange rate. Thus, any deviation of interest rates from equilibrium, either at home or abroad, would result in the exchange rate deviating from equilibrium, unless such rate deviations were identical. Any other movement in exchange rates is captured in the residual in the exchange rate equation, which can be thought of as a temporary shock to the risk premium. We also allow, but do not impose, model-consistent expectations for the exchange rate (i.e., $\delta_z \neq 1$):

$$z^e_t = \delta_z z_{t+1} + (1-\delta_z) z_{t-1}$$

Monetary policy rule

The monetary policy reaction function is a variant of the Taylor rule—a forward-looking rule because interest rates are set as a function of expected future inflation $(\pi^4_{t+4} - \pi^*_{t+4})$ as well as the output gap $ygap$ .When these variables are zero, interest rates are set to "normal" levels $(RR^*_t + \pi^4_t)$. As is standard in reaction functions, we allow for "smoothing" in rate setting by introducing a lag term. The policy instrument is a short-term nominal interest rate and the central bank sets this instrument to anchor inflation to a target level, π *, over time:

$$RS_t = \alpha_1 RS_{t-1} + (1-\alpha_1)(RR^*_t + \pi^4_t + \alpha_2(\pi^4_{t+4} - \pi^*_{t+4}) + \alpha_3 ygap_t + \varepsilon^{RS}_t$$

The Rest of the world (US)

The rest of the world is represented by the U.S. economy. The behavioral equations are similar but without the world influences.

Output gap

$$yusgap_t = \beta_1^{us} yusgap_{t-1} + \beta_2^{us} yusgap_{t+1} - \beta_3^{us} (RRus_{t-1} - RRus_{t-1}^*) + \varepsilon_t^{yus}$$

Phillips curve

$$\pi us_t = \delta_1^{us} \pi us_{t+4}^4 + (1-\delta_1^{us}) \pi us_{t-1}^4 + \delta_2^{us} yusgap_{t-1} + \varepsilon_t^{\pi us}$$

Policy reaction rule

$$RSus_t = \alpha_1^{us} RSus_{t-1} + (1-\alpha_1^{us})(RRus_t^* + \pi us_t^4 + \alpha_2^{us}(\pi us_{t+4}^4 - \pi us_{t+4}^*) + \alpha_3^{us} yusgap_t + \varepsilon_t^{RSus}$$

9. **The model is estimated with Bayesian techniques.** These are based on the influential work of Schorfheide (2000). Papers using a Bayesian approach in the estimation of open economy DSGE models include Lubik and Schorfheide (2003) and Justiniano and Preston (2004). There are several advantages of using Bayesian methods for inference in estimating macroeconomic models. For our purposes, we highlight the fact that because Bayesian methods seek to characterize the posterior distribution of the parameters, they facilitate an accurate assessment of all of the uncertainty surrounding the model's coefficients. Indeed, posterior inference provides us with posterior probability bands without having to assume, for instance, symmetry in these distributions.[4] We briefly sketch our approach to inference, and the reader is referred to the above references for further details. Defining Θ as the parameter space, we wish to estimate the model parameters denoted by $\theta \subset \Theta$. Given a prior $p(\theta)$, the posterior density of the model parameters, θ, is given by:

$$p(\theta|Y^T) = \frac{L(Y^T|\theta)p(\theta)}{\int L(Y^T|\theta)p(\theta)d\theta})$$

where $L(Y^T|\theta)$ is the likelihood conditional on observed data, Y^T. The likelihood function is computed under the assumption of normally distributed disturbances by combining the state-space representation implied by the solution of the linear rational expectations model and the Kalman filter. Our goal is to therefore characterize the posterior density of the parameters. To do so, we follow a two-step approach. In the first step, a numerical algorithm is used to find an initial guess of the posterior mode by combining the likelihood $L(Y^T|\theta)$ with the prior. The posterior mode obtained from this first step is used as the starting value (θ^0) of a multiple chain Random Walk Metropolis algorithm. This Markov Chain Monte

[4] There are also clear advantages when it comes to model comparisons because the models are not required to be nested and numerical methods for the computation of the marginal likelihood permit constructing posterior model probabilities. These probabilities can in turn be used for model averaging, thereby producing parameter estimates that also explicitly incorporate model uncertainty. Furthermore, as emphasized by Smets and Wouters (2003), the use of Bayesian methods provides greater stability to optimization algorithms relative to maximum likelihood.

Carlo (MCMC) method allows us to generate draws from the posterior density $p(\theta|Y^T)$. At each step *i* of the Markov Chain, the proposal density is used to draw a new candidate parameter $\theta^* \propto N(\theta^i, c\Sigma)$. The new draw is then accepted with the following probability:

$$\omega = \min\left\{1, \frac{L(Y^T|\theta^*)p(\theta^*)}{\int L(Y^T|\theta^i)p(\theta^i)}\right\}.$$

If accepted, $\theta_k^{i+1} = \theta_k^*$, otherwise, $\theta_k^{i+1} = \theta_k^i$. The total number of iterations generated in this manner is 100,000 replications in this manner, and we discarded the first 50,000 iterations while monitoring the convergence of the generated draws using potential scale reduction factors and trace plots. The scaling constant for the variance covariance matrix, *c*, is chosen to attain a 30 percent acceptance rate. With the generated draws, point estimates of θ can be obtained from the simulated values by using various location measures, such as means or medians. Similarly, measures of uncertainty follow from computing the percentiles of the draws.

10. **To estimate the model, we use four key macroeconomic series for Thailand and three macroeconomic series for the US.** For Thailand, we use the real GDP, headline CPI inflation rate, the nominal interest rate, and the real bilateral exchange rate. For the US, we use real GDP, headline CPI inflation rate, and the nominal interest rate. Since the model is written in gaps form, we construct exogenously the equilibrium values of the real GDP, the real interest rate, and the real exchange rate using a variant of the Hodrick Prescott filter. To avoid the crisis period, the sample period runs from 1999Q1 to 2007Q2. The data used for the estimation are presented in Figure 1.

11. **The priors are chosen to reflect general considerations of the appropriate model dynamics[5] and our judgment about the Thai economy.** A complete list of all priors used is provided in Table 1. Lags in the transmission mechanism of monetary policy imply that, in the output gap equations, there would be substantial inertia in the evolution of the output gap with only a small forward-looking component, and that the sum of β_3 and β_4 would be smaller than β_1. In relatively open economies such as Thailand, we would also expect that β_4 would be at least as big as β_3. Since the model does not explicitly account for trade, and to capture the importance of U.S. growth for the Thai economy, we allow for a direct, though relatively muted, impact of the U.S. economy on Thai output gap through β_5. In the Phillips curve, δ_1 is a measure of the forward-looking component of inflationary expectations, and it would be decreasing function of the pervasiveness indexation in the economy. As an empirical matter, data from most countries are consistent with a δ_1, significantly below 0.5.

[5] For further details, see Berg and others, IMF Working Paper 06/81.

The parameter δ_2 also depends on the balance between adaptive and rational expectations in the economy, with more backward–looking behavior consistent with larger values of the parameter. Here again, we choose a value, 0.25, that is consistent with data from many countries. The effect of the exchange rate on inflation, δ_3, reflects the pass-through of imported goods prices to domestic inflation. This parameter would typically be an increasing function of the openness of the economy, while remaining considerably smaller than the import weight in the CPI basket.[6] In the uncovered interest parity (UIP) condition, rational expectations would set $\delta_z = 1$, but we assume an intermediate value of 0.5. For the interest rate responses to inflation and output gap, α_2 and α_3, we choose 1.5 and 0.5, consistent with Thailand being an inflation targeting country with a balance between adaptive and rational expectations. In the monetary policy rule, a typical value for the interest rate smoothing parameter, α_1, is between 0.5 and 1, with 1 representing the fullest inertia in monetary policy. We choose a value of 0.5. For the US, the main differences in the choice of priors reflect the assumption that Thailand is too small to affect the U.S. economy, and that the US is isolated from exchange rate shocks. Technically, this means that we assume a zero prior for the foreign output in the output gap equation, and a zero prior for the exchange rate in the output gap equation and the Phillips curve.

III. Results

12. **The estimation produces a number of interesting results.** Table 1 reports the posterior estimates of each parameter. Along with the posterior mean, we present the 5th and 95th percentiles for the posterior distributions, which serve to quantify the uncertainty surrounding these estimates. Most of the estimated parameters are in the ballpark of our priors' assumptions, but a number of the estimates deserve closer scrutiny. The parameter on lagged gap term in the output gap equation is estimated at 0.21, significantly away from its prior mean of 0.7, demonstrating that the Thai economy does not exhibit significant inertia. Moreover, even though that the sum of β_3 and β_4 is estimated to smaller than β_1, as expected, it is not that much so, suggesting only moderate lags in the transmission of monetary policy. This may be related to the fact that the estimated parameter on the lagged interest rate in the monetary policy rule is quite big at 0.84,[7] allowing the

Thailand: Baseline Scenario

	2007	2008	2009
GDP	4.5	5.0	5.2
Inflation	2.3	3.5	3.0
Exchange rate	34.570	34.055	34.055

[6] Berg and others (2006) use 0.1 for a model calibrated to Canada and the US.

[7] Woodford (2001) argues that a high parameter value represents optimal policy inertia. A higher coefficient on the lagged interest rate term implies some persistence in interest rate changes. Thus a small move in interest rates today creates the expectation of further moves in future periods,

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monetary authorities to effect smaller changes in the policy rate that induce larger effects on the real economy. This may be more relevant in an environment where such small changes engender expectations that the direction of monetary policy will persist. The estimated coefficient δ_z suggests that quite adaptive expectations for the exchange rate[8].

13. **The model is solved initially so that the baseline forecast replicates staff baseline projections over the medium term**. Following solid growth of 5 percent in 2006, growth in the first half of 2007 slowed to 4.3 percent (year-on-year). Low confidence has battered domestic demand, and growth was supported exclusively by external demand. For the year, staff estimates growth at 4.5 percent. Going forward, 2008 growth is projected at 5 percent, accelerating to 5.2 percent in 2009. This forecast is based on the assumption of rotation of demand from external to domestic sources and, therefore, already takes into account some slowdown in the U.S. economy.[9] The baseline projection for the US is based on the September U.S. desk forecast. Growth slows from 2.9 percent in 2006 to 2.25 percent in both 2007 and 2008.

14. **Next, the model is used to evaluate the risk to the baseline scenario stemming from a slowdown in U.S. growth.** The main advantage of the model is that it can serve to frame the analysis about the baseline forecast, risks to the forecast, appropriate responses to an external demand shock, and the dependence of the forecast and policy recommendations on various sorts of assumption about the functioning of the economy.

15. **We analyze two main risk scenarios, and estimate that output in Thailand may decline by up to 0.9 percent relative to baseline.** We shock the output gap equation in the US in such a way that 2008 U.S. GDP falls by 100 basis points from 2.25 percent to 1.25 percent. This is consistent with the lower end of the revised U.S. forecast of the October WEO, which lowers the point estimate for growth in 2008 to 1.9 percent, with 1.25 percent falling within the 90 percent confidence band. First, we assume that monetary policy in Thailand fails to anticipate initially the timing of the shock and does not respond to the external disturbance for two quarters. Only after that does monetary policy allow the policy rate to adjust downwards to the fall in Thai output. Second, we allow for an immediate (model-based) response of monetary policy to the fall in U.S. output:

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therefore, allowing a small move today to have a relatively large impact on agents' behavior and creating a relatively swift transmission mechanism from monetary policy.

[8] Isard and Laxton (2000).

[9] Since the estimation and simulation of the model, staff has updated slightly upwards its baseline forecast for Thailand in 2008 and 2009. However, the main value of the exercise presented here is to measure the impact of a U.S. shock on Thailand *relative* to a baseline. Because of the linearity of the model, the results should be robust to a change in baseline.

- *Delayed monetary policy response*: the negative external demand shock directly affects Thai output, which bottoms in the second quarter of 2008. The annual impact on output is significant. GDP growth falls by 0.9 percentage points below the baseline in 2008, before recovering in 2009. Because of the presence of forward-looking features in the model, output begins slowing down relative to baseline in the third quarter of 2007, even though the shock occurs only at the beginning of 2008. Declining output translates into lower inflation, while the UIP condition dictates that the real exchange rate appreciates, because foreign interest rates fall by more than domestic interest rates.

- *Immediate monetary policy response*: the impact on Thai output is still appreciable, with GDP growth falling 0.6 percentage points below baseline. Therefore, the accommodative response of monetary authorities helps mute the decline in output by 0.3 percent. The qualitative response of inflation and the exchange rate are similar to the previous case.

16. **However, the adverse impact on Thai output is likely to be smaller than suggested above.** The model incorporates a number of assumptions that may amplify the negative impact on output. For example, it does not incorporate a fiscal policy response that could be used to rebalance growth from external to domestic sources. Nor does it incorporate a risk premium.[10] Most importantly, since we employ a standard two-country framework in the assessment, there is an implicit assumption that the US is Thailand's only trade partner, which magnifies the estimated impact coefficient.

17. **To be more specific, the co-efficient which measures the impact of the U.S. output gap on Thai GDP in the investment-savings curve equation will be biased upwards due to omitted variables.** This bias is an increasing function of the correlation between the U.S. business cycle and the business cycle of Thailand's other trade partners. Ideally, we would like to estimate the output gap equation with not just the U.S. output gap on the right-hand side (RHS), but the output gap of every one of Thailand's trade partners, particularly important partners such as China, emerging Asia, the EU, and Japan. Assuming that there is a positive correlation between the business cycles of Thailand's various trade partners, our two-country model will yield an exaggerated co-efficient for the U.S. output gap, which picks up not only the impact of the U.S. economy but also of other, correlated trade partners.[11]

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[10] The UIP condition could be augmented by a risk premium that may render the resulting exchange rate appreciation less sensitive to the interest rate differential, which in turn may dampen the fall in output growth.

[11] One way to think about this is to consider a world in which there is zero correlation between the U.S. economy's business cycle and those of China, the EU, and other Thai trade partners. In this world, our two-country model would yield an unbiased estimate of the impact of the U.S. economy on Thailand, because the U.S. economy is orthogonal to other trade partners. Next, consider a world in which there is a positive

(continued…)

18. **A lower bound on the impact on Thai output is provided by weighting the estimated impact co-efficient by the U.S. share of Thailand's exports.** This is equivalent to assuming perfect correlation between the U.S. economy and Thailand's other trade partners (as opposed to the zero correlation assumed in the earlier estimate), so that the estimated parameter picks up the impact of a coincident slowdown in all of Thailand's trade partners, and hence needs to be adjusted. As noted earlier, although the US is Thailand's largest single trade partner, it accounts for only about 15 percent of Thai exports. Therefore, in this third scenario, the fall in Thai GDP is a modest 0.135 percentage points below baseline.

IV. Confidence Intervals

19. **Bayesian analysis can be used to construct confidence intervals for output responses.** While the previous analysis was based on calibrating the model with the posterior means of the estimated parameters, the Bayesian analysis allows for a broader characterization of the output response. In particular, since we estimate a posterior distribution, we could also construct confidence intervals, depicting a range of possible values for the effect of foreign output on domestic output. In Figure 3, we show the confidence intervals of the output response in the immediate policy response scenario over the marginal distribution of particular parameters. For example, the first panel shows the 90 percent lower and upper bound of output response as α_1, the coefficient measuring the aggressiveness of monetary policy to changes in inflation, ranges from its 5 percent level to its 95 percent level, while keeping all other parameters at their posterior mean.

20. **We examine the confidence intervals for output for all estimated parameters, but for most of them, the resulting confidence intervals around the immediate policy response scenario are quite tight.** This may be because a given parameter is very tightly estimated or because it has limited bearing on the dynamic responses of output. Therefore, we report only those confidence intervals that exhibit somewhat wider bands around the immediate policy response scenario.

V. Conclusion

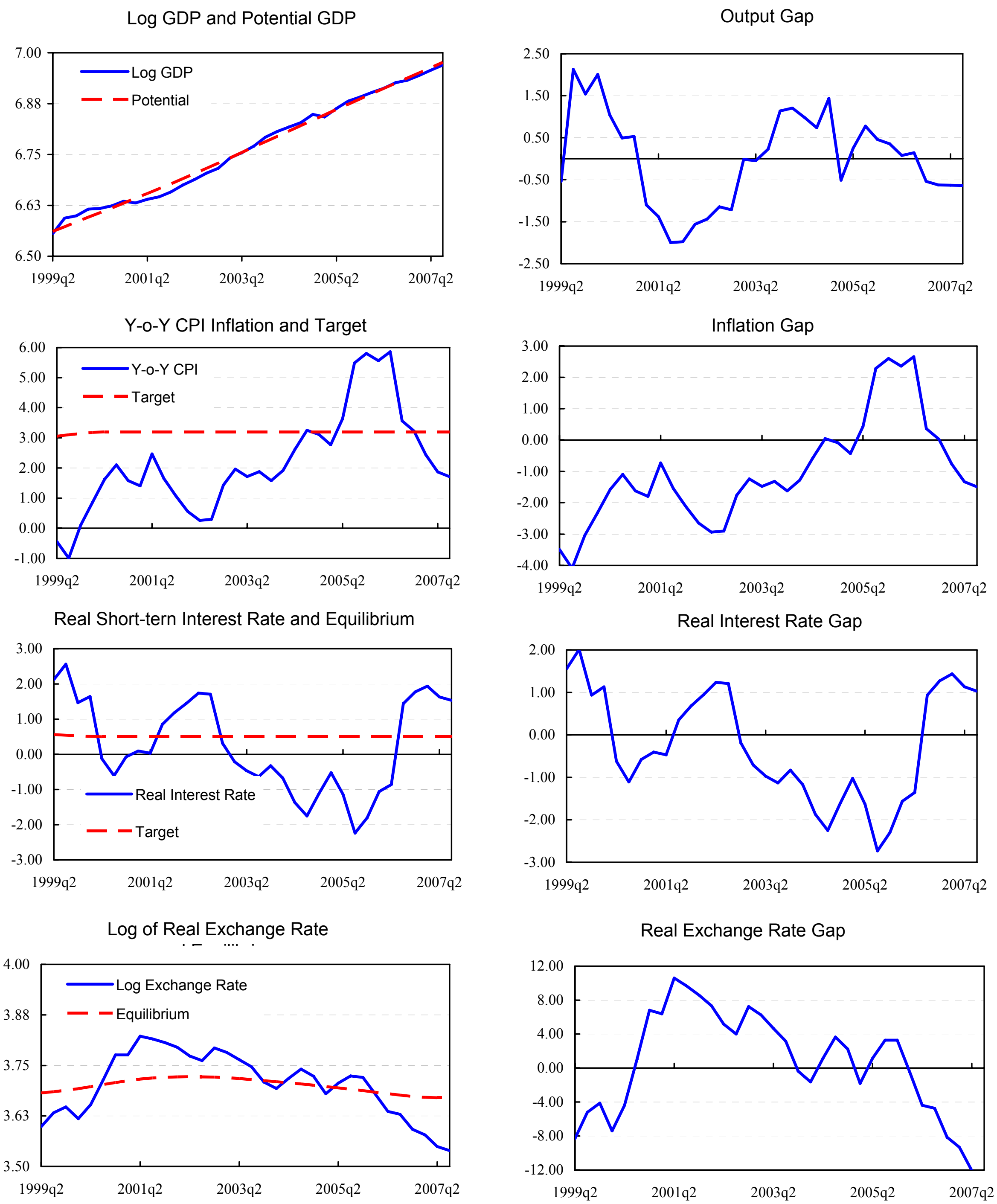
21. **This paper has parameterized a New Keynesian, general equilibrium model of the Thai and U.S. economy, and to thereby obtain an estimate of the impact of a U.S. slowdown on Thailand.** By using a *small* structural model and by employing Bayesian updating in estimation, the paper attempts to keep the postulated economic mechanisms

correlation of unity between the U.S. economy and China, the EU etc. In this world, our two-country model estimate of the U.S. impact on Thailand would actually represent the impact of a slowdown in all of Thailand's trade partners, and thus be a considerable overestimate.

transparent and amenable to policy discussion, while allowing the parameters to reflect a balance between expert judgment and the historical record.

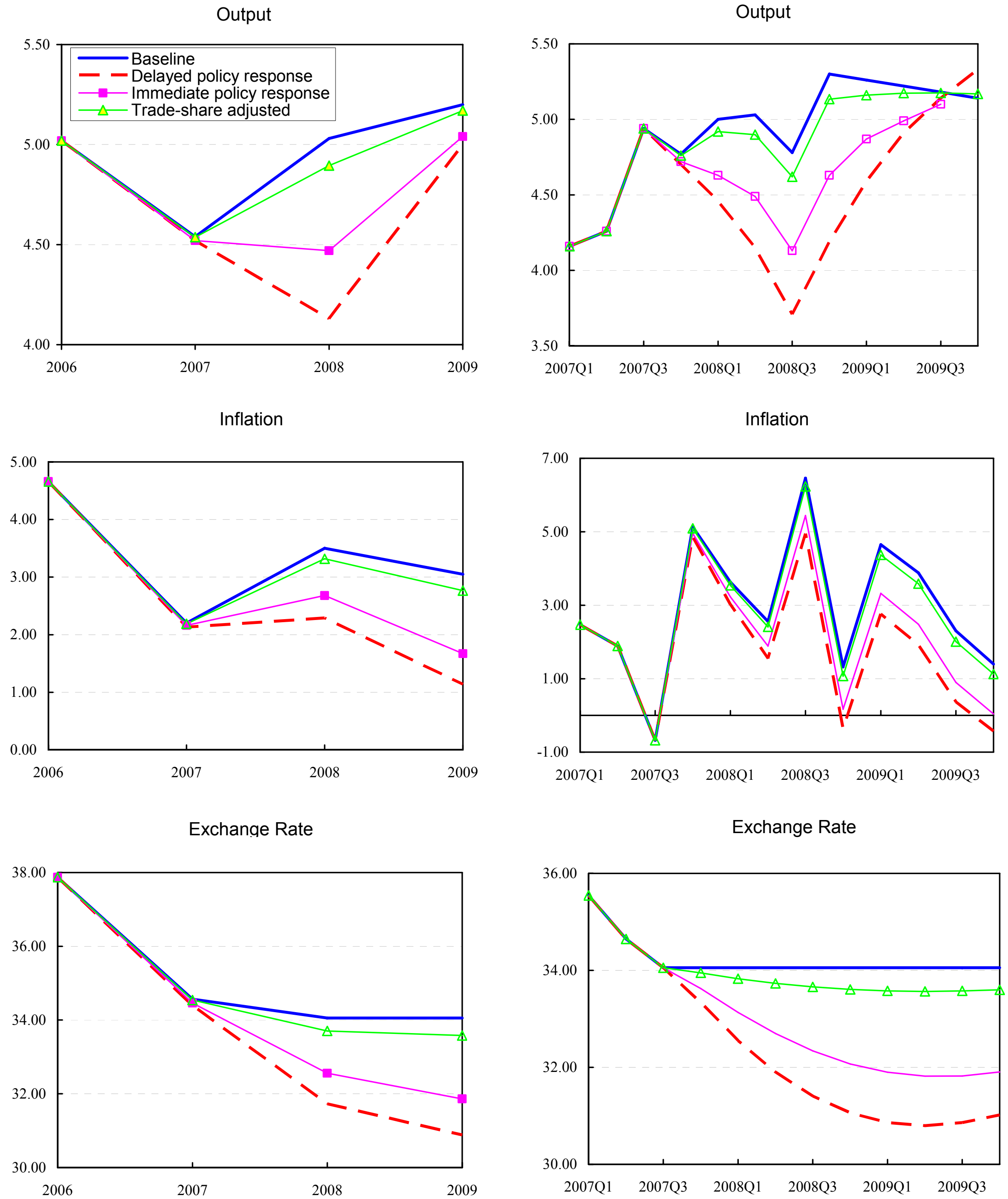
22. **So, to return to the title of this paper, are the fears of a U.S. slowdown simply much ado about nothing?** More precisely, is the likely impact on Thailand's growth prospects small enough to be dominated by domestic demand conditions? The answer is a qualified yes. While the impact is nontrivial, it is indeed small compared to the movements in domestic demand expected in 2008, as the country moves forward from a period of political turbulence and depressed investor confidence. We estimate that a slowdown in U.S. growth of 100 basis points relative to the baseline could have an upper-bound impact on Thai GDP growth of about 0.9 percentage points, and a lower-bound impact of 0.135 percentage points. Where exactly the impact lies between these two bounds depends on the correlation between the US and Thailand's other trade partners. The midpoint of the range is 0.52 percentage points. Moreover, a quicker monetary policy response could reduce any potential impact by 0.3 percentage points.

Figure 1: Thailand. Data Used for Estimation



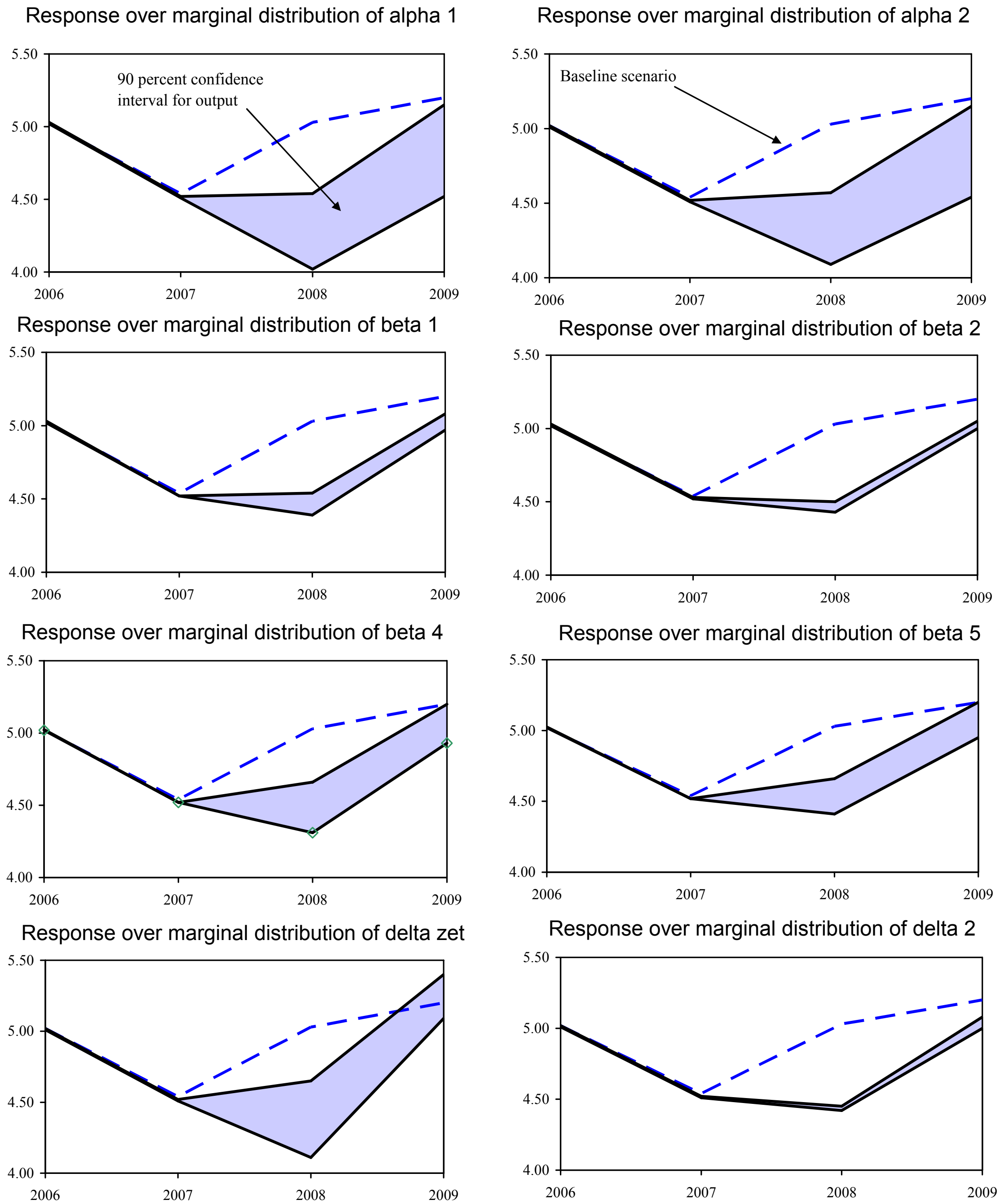
Source: IMF staff estimates.

Figure 2: Thailand. Responses to a 1 percent Slowdown in U.S. Growth



Source: Authors' calculations.
Note: This figure depicts the dynamic responses of Thai output to a negative 1 percent shock to U.S. output under different scenarios.

Figure 3: Robustness - Confidence Intervals of GDP Growth Responses



Source: Authors' calculations.
Note: The Bayesian posterior distribution is estimated jointly over all parameters. Above, we show the confidence intervals of the output response in the immediate policy response scenario over the marginal distribution of particular parameters. For example, the first panel shows the 90 percent lower and upper bound of output response as alpha 1 ranges from its 5 percent level to its 95 percent level, while keeping all other parameters at their posterior mean.

Table 1: Model Parameter Estimation Results

	Prior Distribution			Posterior Distribution		
Parameter	Type	Mean	Standard Error	5%	Mean	95%
Domestic						
β_1	Beta	0.70	0.20	0.059	0.210	0.349
β_2	Beta	0.10	0.03	0.052	0.097	0.144
β_3	Gamma	0.10	0.03	0.052	0.095	0.149
β_4	Beta	0.10	0.03	0.051	0.104	0.144
β_5	Beta	0.10	0.03	0.049	0.101	0.148
δ_1	Gamma	0.30	0.06	0.195	0.260	0.472
δ_2	Gamma	0.25	0.06	0.114	0.182	0.257
δ_3	Gamma	0.30	0.06	0.200	0.283	0.365
δ_z	Beta	0.50	0.10	0.310	0.411	0.526
α_1	Beta	0.50	0.10	0.786	0.839	0.911
α_2	Gamma	1.50	0.40	0.661	1.417	1.931
α_3	Beta	0.50	0.10	0.170	0.307	0.482
Foreign						
β_1^{us}	Beta	0.70	0.20	0.589	0.744	0.925
β_2^{us}	Beta	0.10	0.03	0.053	0.103	0.152
β_3^{us}	Gamma	0.10	0.03	0.063	0.115	0.173
δ_1^{us}	Beta	0.20	0.06	0.111	0.204	0.317
δ_2^{us}	Gamma	0.30	0.06	0.170	0.252	0.333
α_1^{us}	Beta	0.50	0.10	0.393	0.531	0.676
α_2^{us}	Gamma	2.00	0.40	1.247	1.884	2.498
α_3^{us}	Beta	0.50	0.10	0.360	0.511	0.687

Sources: Bank of Thailand and Ministry of Finance.

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