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EVALUASI DAMPAK BENCANA TSUNAMI 2004 TERHADAP KINERJA PEREKONOMIAN PROVINSI ACEH: APLIKASI *SYNTHETIC CONTROL METHODS*

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RINGKASAN

Pada penelitian tahun pertama telah diketahui bahwa tsunami yang melanda Aceh pada tahun 2004 memiliki dampak yang sangat signifikan terhadap pertumbuhan ekonomi Aceh, terutama bila dilihat dari sisi Pendapatan Domestik Regional Bruto (PDRB). Dampak tadi diukur dengan menggunakan metode *synthetic control methods* (SCM) dengan menambahkan *comparing time series procedure* untuk menghindari masalah *donor pool* pada SCM.

Seperti diketahui secara umum, di tahun yang sama selain Aceh, Thailand dan Srilanka juga mengalami bencana tsunami ini. Pada penelitian lanjutan ini akan dibandingkan dampak tsunami yang menimpa Aceh dan Thailand. Hal yang ingin diketahui adalah kecepatan pemulihan ekonomi dari kedua negara yang dilanda bencana tsunami tersebut. Hasil-hasil temuan penelitian dapat menjadi pijakan bagi *policy makers*, ketika memformulasikan kebijakan publik (*public policy*) yang terkait dengan bencana alam.

Kata kunci: bencana alam, tsunami, perekonomian, *synthetic control methods*, kebijakan publik

PRAKATA

Ucapan syukur dan terima kasih, kami panjatkan kepada Tuhan Yesus Kristus, yang telah memberikan kesempatan dan perkenanaan sehingga Penelitian Hibah Bersaing dengan Judul: Evaluasi Dampak Bencana Tsunami 2004 terhadap Kinerja Perekonomian Provinsi Aceh: Aplikasi *Synthetic Control Methods* untuk tahun anggaran 2013/2014 telah dilaksanakan.

Untuk tahun pertama penelitian, kami telah mencoba mengkaji dampak bencana tsunami di Aceh lewat melakukan pemodelan dengan aplikasi *synthetic control methods* dimana dengan memperlakukan Aceh sebagai *experimental unit* dan memilah provinsi mana yang memiliki karakter yang mirip dengan Aceh sebelum tsunami terjadi atau disebut *synthetic group*, membantu kami melihat besaran dampak yang diberikan oleh bencana alam tsunami Desember 2004.

Pada tahun kedua penelitian ini, kami mengembangkan kajian dampak bencana tsunami untuk wilayah-wilayah di Samudra Hindia yang terlanda bencana ini. Wilayah-wilayah tersebut adalah: Aceh di Indonesia dan Phuket, Krabi, Phang Nga, Trang, Ranong dan Satun di Thailand

Temuan dalam penelitian ini menunjukkan bahwa dampak tsunami memang sangat berperan terhadap kemunduran pertumbuhan ekonomi (diukur dari Produk Domestik Regional Bruto - PDRB per capita) di provinsi-provinsi tersebut.

Hasil dari *Synthetic control method* menunjukkan bahwa di tahun 2005, PDRB Aceh 16,24% lebih rendah bila dibandingkan dengan provinsi-provinsi sintetiknya dan secara rata-rata PDRB Aceh 27,02% lebih rendah bila dihitung sejak tsunami terjadi. Bila dibandingkan dengan Phuket di Thailand, di tahun 2005, PDRB Phuket 21,95% lebih rendah bila dibandingkan dengan provinsi-provinsi sintetiknya, namun secara rata-rata PDRB Phuket PDRB ini hanya turun 3,08% bila dihitung sejak tsunami terjadi. Hal ini menunjukkan perbaikan ekonomi di Phuket jauh lebih cepat bila dibandingkan dengan Aceh.

Adanya perbedaan pemulihan yang cukup besar ini menarik untuk dipelajari untuk memberikan pelajaran berharga bagi Indonesia untuk segera bangkit apabila terjadi bencana.

Surabaya, 1 November 2014

Penulis

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BAB 1

PENDAHULUAN

1.1. Latar Belakang

Seiring dengan fenomena pemanasan global (*global warming*), intensitas dan potensi terjadinya bencana alam mengalami peningkatan sepanjang waktu. Kerentanan suatu wilayah terhadap bencana alam juga dipengaruhi oleh posisi geologis wilayah tersebut. Indonesia sebagai negara yang secara geologis terletak pada pertemuan tiga lempeng tektonik aktif didunia, yaitu lempeng Indo-Australia, lempeng Eurasia, dan lempeng Pasifik, akan selalu menghadapi ancaman bencana alam.

Tidak dapat dipungkiri, dampak yang ditimbulkan dari terjadinya suatu bencana alam sangatlah besar, mengingat hal ini bersifat multiplikatif (Hochrainer, 2006; Cavallo dan Noy, 2011). Dampak awal atau yang dikenal sebagai dampak langsung (*direct effect*) dari bencana alam dapat diidentifikasi melalui kerusakan-kerusakan pada aset-aset tetap dan kapital, hilangnya sumber daya alam ekstraktif, serta tingginya insiden mortalitas dan morbiditas. Pada tahapan lebih lanjut, dampak-dampak langsung ini akan menyebabkan kemerosotan aktivitas perekonomian wilayah yang sedang dilanda bencana alam tersebut atau dikenal sebagai dampak tidak langsung (*indirect effect*). Barro (2006, 2009) menunjukkan bahwa biaya kesejahteraan (*welfare costs*) yang ditimbulkan dari suatu bencana alam jauh lebih besar jika dibandingkan dengan biaya kesejahteraan dari terjadinya guncangan-guncangan ekonomi (*economic shocks*) reguler. Untuk negara-negara maju, Barro memperkirakan *welfare costs* dari bencana alam setara dengan 20% dari Produk Domestik Bruto (PDB), sedangkan fluktuasi ekonomi biasa hanya menimbulkan *welfare costs* sekitar 1,5% dari Produk Domestik Bruto (PDB). Lebih lanjut, Barro mengungkapkan bahwa *welfare costs* dari terjadinya bencana alam di negara-negara berkembang jauh melebihi *welfare costs* dari bencana alam di negara-negara maju, mengingat kelompok negara ini lebih sering dilanda bencana alam dalam derajat yang lebih berat.

Sebagaimana diketahui bersama, tepat satu hari setelah perayaan Natal, tanggal 26 Desember 2004, gempa bumi berkekuatan 9,0 skala Ritcher yang berpusat di Samudera Hindia melanda Provinsi Aceh dan daerah di sekitar Pantai Phuket-Thailand. Gempa bumi ini diikuti oleh gelombang tsunami dahsyat yang meluluhlantakkan sendi-sendi perekonomian daerah-daerah ini. Untuk Aceh total estimasi kerusakan dan kehilangan dari tsunami ini adalah sebesar US$ 4,45 miliar atau setara dengan 80% Produk Domestik Regional Bruto (PDRB) Provinsi Aceh pada tahun 2004. Lebih lanjut, dilaporkan bahwa 78% dari total kerusakan ini harus ditanggung oleh sektor swasta, termasuk rumah tangga, sedangkan 22% sisanya menjadi beban sektor publik (Bappenas dan International Community, 2006). Peristiwa yang merupakan bencana alam terburuk yang pernah dicatat dalam sejarah Indonesia setelah erupsi Gunung Krakatau pada tahun 1883, diperkirakan mengakibatkan hilangnya lebih dari 150.000 nyawa dan menyebabkan 700.000 orang kehilangan rumah (Athukorala dan Resosudarmo, 2005; Masyrafah dan McKeon, 2008). Laporan resmi dari Bangkok Post menggambarkan effek yang ditimbulkan oleh tsunami di Thailand seperti terlihat pada Tabel 1.

Tabel 1. Gambaran efek tsunami yang menimpa Thailand

Province	Thai deaths	Foreign deaths	Total deaths	Thai injured	Foreign injured	Total injured	Missing
Krabi	288	188	476	808	568	1,376	890
Phang Nga	1,950	2,213	4,163	4,344	1,253	5,597	2,113
Phuket	154	105	259	591	520	1,111	700
Ranong	167	2	169	215	31	246	12
Satun	6	0	6	15	0	15	0
Trang	3	2	5	92	20	112	1
Total	2,568	2,510	5,078	6,065	2,392	8,457	3,716

Sumber: *Bangkok Post*

Berbeda dengan studi-studi jangka pendek tentang evaluasi bencana tsunami yang telah dilakukan sebelumnya (misalnya: Asian Development Bank, 2005; Athukorala dan Resosudarmo, 2005; Rofi, Doocy dan Robinson, 2006; dan Masyrafah dan McKeon, 2008), penelitian ini menggunakan desain ekperimental, yakni dengan cara memperlakukan Provinsi Aceh sebagai *experimental unit* dan menganggap Provinsi-provinsi lain di Indonesia sebagai *control units*. Desain eksperimental sangat sesuai untuk mengevaluasi dampak bencana tsunami, sebab: (1) ketersediaan data makroekonomi yang sangat detail pada level regional (provinsi) dan dalam rentang waktu yang panjang baik pre- maupun pasca- tsunami, (2) Provinsi-provinsi lain yang tidak dihantam oleh tsunami dapat menjadi *unit* kontrol (*control units*) bagi Provinsi Aceh selaku *unit* yang mendapat perlakuan (*treated unit*), (3) gelombang tsunami tersebut terjadi secara tidak terduga (*unexpected*) dan tidak biasa (*unusual*), sehingga bencana alam ini tergolong kejadian yang benar-benar eksogen (*exogenous event*).

Sebagai studi tentang evaluasi dampak, tantangan terbesar yang dihadapi oleh peneliti adalah menemukan kontrafaktual (*counterfactual*) dari Provinsi Aceh. Dalam kalimat lain, pada kondisi ideal, peneliti seharusnya memiliki informasi yang lengkap tentang perekonomian Provinsi Aceh seandainya bencana tsunami tidak terjadi. Faktanya, peneliti hanya mempunyai data-data ekonomi dari Provinsi Aceh pasca tsunami. Dalam rangka untuk mendapatkan informasi yang hilang ini, peneliti menggunakan *synthetic control methods,* sebagaimana dipergunakan oleh Abadie *et al.* (2010). *Synthetic control methods* bekerja melalui dua tahapan. Langkah pertama adalah penentuan *synthetic unit* (*control unit*) yang dilakukan dengan cara membandingkan karakteristik-karakteristik perekonomian Provinsi Aceh dan Provinsi-provinsi lain pre-tsunami. Provinsi yang memiliki ciri-ciri perekonomian yang menyerupai karakteristik-karakteristik perekonomian Provinsi Aceh dipilih sebagai *synthetic unit*. Pada tahap berikutnya, dilakukan perbandingan kinerja perekonomian pasca tsunami antara *synthetic unit* dan Provinsi Aceh. Perbedaan kinerja perekonomian diantara kedua *unit* ini adalah efek kausal (*causal effect*) dari tsunami. Benefit terbesar dari penggunaan metode ini adalah kemampuannya dalam mengakomodasi karakteristik-karakteristik dari provinsi yang bervariasi sepanjang waktu (*time variant characteristics*), dan hal ini menimbulkan bias pada model yang sedang estimasi.

Pada penelitian terdahulu (Halim et al. 2013) telah diketahui bahwa tsunami yang melanda Aceh pada tahun 2004 memiliki dampak yang sangat signifikan terhadap pertumbuhan ekonomi Aceh, terutama bila dilihat dari sisi Pendapatan Domestik Regional Bruto (PDRB). Pada penelitian lanjutan ini akan dibandingkan dampak tsunami yang menimpa Indonesia dan Thailand. Hal yang ingin diketahui adalah seberapa cepat ketiga negara tersebut mampu bangkit kembali dari keterpurukan akibat bencana tsunami. Hasil-hasil temuan penelitian dapat menjadi pijakan bagi *policy makers*, ketika memformulasikan kebijakan publik (*public policy*) yang terkait dengan bencana alam.

1.2. Rumusan Masalah

Berdasarkan pemaparan diatas, studi ini merumuskan permasalahan tunggal yang akan diteliti, yakni:

Bagaimanakah dampak tsunami 2004 terhadap perekonomian Aceh (Indonesia), Phuket, Krabi, Phang Nga, Trang, Ranong dan Satun (Thailand)?

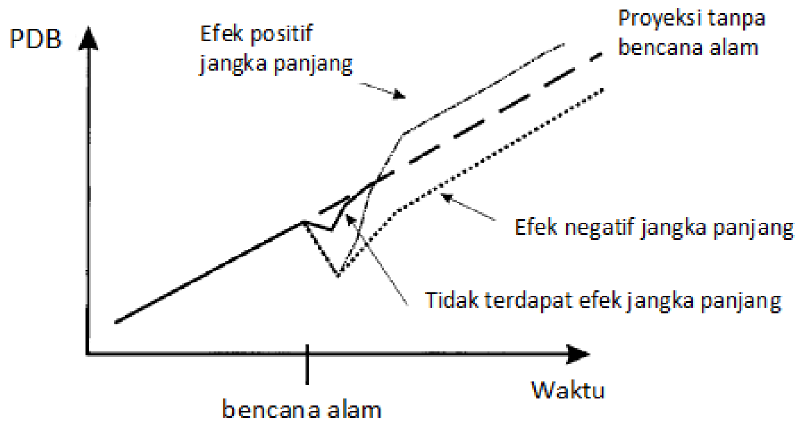
BAB 2
TINJAUAN PUSTAKA

State of the Art Dampak Bencana Alam terhadap Variabel-Variabel Ekonomi

Literatur-literatur tentang dampak makroekonomi dari bencana alam dapat diklasifikasikan berdasarkan durasi waktu dari dampak bencana alam tersebut, yaitu studi-studi yang sifatnya jangka pendek dan menengah (1-5 tahun) serta studi-studi jangka panjang (di atas 5 tahun). Selama ini, kajian-kajian tentang dampak bencana alam cenderung didominasi oleh perspektif jangka pendek dan menengah, sedangkan analisa-analisa jangka panjang tentang dampak bencana alam hanya mendapatkan perhatian kecil saja. Menariknya, respon variabel-variabel makroekonomi terhadap bencana alam juga bervariasi, tergantung dari jangka waktu analisa. Pada bagian ini akan dibahas reaksi perekonomian setelah terjadinya bencana alam.

2.1. Produk Domestik Bruto dan Pertumbuhan Ekonomi

Produk Domestik Bruto (PDB) adalah salah satu besaran makroekonomi yang mendapat perhatian utama, setelah terjadinya *shocks* dalam perekonomian atau dalam hal ini berupa bencana alam. Gambar 1 menyajikan skenario-skenario pergerakan PDB setelah terjadinya bencana alam.



Gambar 1. Pergerakan PDB setelah bencana alam (Sumber: Hochrainer, 2006)

Pada prinspinya, *trajectory* PDB tidak dapat diprediksikan dengan sempurna setelah kejadian bencana alam. PDB dapat berfluktuasi kearah trend positif, negatif, atau tidak beraksi terhadap bencana alam (Gambar 1). Sampai kini pun, para ekonom belum mencapai konsensus tentang variabilitas PDB dan bencana alam. Satu hal yang telah diterima secara umum adalah PDB dipengaruhi secara negatif pada saat terjadinya bencana alam. Dipihak lain, Skidmore dan Toya (2002) menunjukkan jika bencana alam berdampak positif terhadap level GDP. Penulis menggunakan konsep *stock* dan *flow* untuk mendukung temuan mereka. Menurut Skidmore dan Toya (2002), bencana alam akan menghancurkan stok kapital pada awalnya. Tetapi, mengingat PDB diukur dari *flow* produksi barang-barang dan jasa baru yang ditimbulkan oleh kehancuran ini, nilainya akan meningkat.

Trend ini juga berlaku bagi pertumbuhan ekonomi. Teori pertumbuhan ekonomi sendiri memang tidak memiliki jawaban pasti tentang pertanyaan bagaimana dampak bencana alam terhadap pertumbuhan ekonomi. Model pertumbuhan neo-klasik memprediksikan bahwa kerusakan kapital (fisik atau sumber daya manusia) tidak mempengaruhi kemajuan teknologi. Dengan demikian, kejadian ini hanya akan berdampak pada prospek pertumbuhan jangka pendek. Sebaliknya, model-model pertumbuhan endogen memberikan prediksi yang ambigu terakit dengan fluktuasi ouput. Model-model pertumbuhan endogen yang diturunkan berdasarkan proses *creative destruction* meramalkan bahwa pertumbuhan ekonomi tinggi biasanya mengikuti *negative shocks*, karena goncangan-goncangan ini dapat menjadi katalis bagi kegiatan re-investasi dan peningkatan barang-barang kapital. Berlawanan dengan model Schumpeter ini, model pertumbuhan endogen AK yang mengasumsikan jika teknologi memberikan tingkat pengembalian konstan terhadap kapital, memprediksikan tiadanya perubahan pertumbuhan ekonomi setelah terjadinya *negative shocks*. Variant lain dari model AK yang dibentuk dibawah asumsi *increasing returns to scale* dalam proses produksi, menghasilkan kesimpulan yang berlawanan. Model ini mendalilkan jika kerusakan capital akan menyebabkan pertumbuhan ekonomi rendah dan hal ini bersifat permanen (Cavallo *et al*., 2010).

Studi-studi empiris yang telah dilakukan juga tidak menunjukkan konsistensi dari model-model pertumbuhan ekonomi. Cavallo *et al*. (2010) menemukan hanya bencana alam yang dashyat yang akan menghasilkan efek negatif terhadap *output* baik dalam jangka pendek maupun jangka panjang, sedangkan bencana alam kecil, tidak berdampak pada output. Namun demikian, setelah melakukan kontrol terhadap perubahan-perubahan institusional, dampak negatif dari bencana alam yang hebat tersebut menghilang. Dengan menggunakan data panel dari negara-negara berkembang, Raddatz (2007) menyimpulkan jika dampak merugikan dari bencana alam terhadap output hanya dirasakan dalam jangka pendek saja. Hasil temuan ini juga didukung oleh studi Noy (2009) yang mengeksploitasi variabilitas antar negara dengan menggunakan estimator *random effects* dari Hausman-Taylor. Lebih lanjut, Noy (2009) menekankan bahwa kondisi struktural dan institusional yang baik, dapat mengelminasi dampak bencana alam.

2.2. Partisipasi Sekolah

Hubungan antara bencana alam dan sektor pendidikan juga menjadi salah satu perhatian para pembuat kebijakan publik. Secara teoritis, dampak bencana alam terhadap investasi pendidikan bersifat ambigu. Aliran pertama memprediksikan bahwa bencana alam akan menurunkan *expected return* dari modal fisik, sehingga individu yang rasional akan cenderung mengalihkan investasinya kedalam modal manusia (Skidmore dan Toya, 2002). Kelompok kedua mengasumsikan jika agen ekonomi (yaitu individu) memiliki waktu hidup yang terbatas. Dengan demikian, mengingat tingkat mortalitas naik mengikuti kejadian bencana alam,maka investasi pendidikan akan lebih rendah diwilayah yang dilanda bencana alam. Fakta ketiadaan model teoritis tunggal yang mampu memprediksikan efek bencana alamdan akumulasi sumberdaya manusia, menuntut dilakukannya kajian-kajian secara empiris (Cuaresma, 2009).

Dengan menggunakan *Bayesian Model Averaging* (BMA), hasil studi Cuaresma (2009) mengindikasikan bahwa bencana alam geologi menjadi faktor penjelas perbedaan angka partisipasi sekolah menengah antar negara. Efek maksimum dari bencana geologi terhadap angka partisipasi sekolah menengah diestimasi sebesar 20%.Temuan ini berbeda denganhasil penelitian Baez dan Santos (*forthcoming*), dimana tingkat partisipasi sekolah ternyata tidak dipengaruhi oleh badai di Amerika Tengah pada tahun 1998.

BAB 3
TUJUAN DAN MANFAAT PENELITIAN

3.1 Tujuan Penelitian

Adapun tujuan-tujuan yang hendak dicapai dalam penelitian ini adalah mengevaluasi dampak bencana tsunami terhadap besaran ekonomi daerah-daerah di Indonesia dan Thailand yang dilanda tsunami. Variabel-variabel tersebut meliputi:

- Pertumbuhan ekonomi dan pendapatan per kapita
- Pengangguran, kesempatan kerja dan upah
- Kemiskinan dan ketidakmerataan distribusi pendapatan
- Surplus/Defisit Anggaran Pendapatan dan Belanja Dearah (APBD)
- Partisipasi sekolah
- Membandingkan effek untuk masing-masing wilayah yang dipelajari

3.2. Manfaat Penelitian

Penelitian ini tidak secara langsung menghasilkan model kebijakan mitigasi bencana alam. Namun demikian, hasil-hasil penelitian diharapkan dapat memberikan input bagi *policy makers*, ketika memformulasikan kebijakan publik (*public policy*) yang terkait dengan bencana alam.

Systematic review oleh Skoufias (2003) menyajikan beberapa opsi intervensi pemerintah dalam usaha meminimalisasi *exposure* dan dampak bencana alam. Studi tersebut juga menggarisbawahi peran marginal pemerintah dalam upaya pencegahan dan mengurangi efek bencana alam di negara-negara dunia ketiga. Sebagai konsekuensi dari keterbatasan ketersedian dan *coverage* jaring pengaman sosial (*social safety net*), bencana alam akan menjadikan negara-negara berkembang terus terperangkap kedalam lingkaran setan kemiskinan (*vicious circle of poverty*).

Ketika menghadapi bencana alam, Skoufias (2003) menjelaskan ketiadaan jaring pengaman sosial akan memaksa rumah tangga, terutama kelompok rumah tangga berpendapatan rendah, menjalankan pengaturan-pengaturan manajemen resiko (*risk management arrangements*) dan strategi-strategi manajemen risiko (*risk management strategies*) sebagai alat proteksi diri. Salah satu jenis mekanisme *self-insurance* yang sangat merugikan adalah kemerosotan investasi sumber daya manusia. Hal ini berwujud penurunan kemampuan rumah tangga dalam menyediakan nutrisi yang layak dan memberikan layanan kesehatan yang baik bagi anak-anak mereka. Tidak jarang kelompok rumah tangga miskin ini memaksa anak-anak yang sedang duduk dibangku sekolah untuk melakukan aktivitas-aktivitas yang dapat menambah pendapatan keluarga (misalnya: bekerja paruh waktu) atau bahkan menghentikan sekolah (*drop out*) mereka. Studi dari Cuaresma (2009) menunjukkan hubungan signifikan negatif antara investasi pendidikan dan risiko tejadinya bencana alam. Secara khusus, dengan menggunakan sampel antar negara (*cross country sample*), Cuaresma menemukan bahwa terjadinya bencana alam disertai dengan penurunan tingkat partisipasi sekolah.

Penelitian ini juga mengkaji dampak tsunami terhadap tingkat partisipasi sekolah. Jika hasil penelitian ini konsisten dengan studi sebelumnya, maka model-model kebijakan yang mentargetkan pada pembangunan sumber daya manusia (*targeted human capital development*) merupakan pilihan tepat sebagai respon atas bencana alam. Sesungguhnya, Indonesia telah mengadopsi model-model kebijakan seperti ini sejak tahun 2007, dengan meluncurkan program bantuan tunai bersyarat (*conditional cash transfers program*) atau Program Keluarga Harapan (PKH) yang ditujukan bagi keluarga miskin. Instrumen intervensi ini menghasilkan manfaat ganda, yakni tidak hanya meningkatkan investasi sumber daya manusia tetapi juga mengurangi tingkat kemiskinan dan disparitas pendapatan. Program-program kerja publik (*public work*), bantuan untuk pengangguran (*unemployment assistance*), dan program pemberdayaan ekonomi masya-rakat juga merupakan solusi rasional untuk mengurangi efek dari bencana alam.

Implikasi hasil-hasil penelitian ini juga menjadi bagian integral dari formulasi kebijakan fiskal (*fiscal policy*), terutama kebijakan fiskal daerah. Para ekonom meyakini bahwa kebijakan fiskal *counter-cyclical*, kenaikan belanja pemerintah dan pemotongan pajak, merupakan jenis kebijakan tepat untuk menanggulangi dampak bencana alam. Tetapi, Ilzetzki and Végh (2008) menemukan bahwa negara-negara berkembang cenderung mengadopsi kebijakan fiskal *pro-cyclical*, penurunan belanja pemerintah dan kenaikan penerimaan pemerintah, mengikuti bencana alam, dan tren ini justru akan mengakibatkan *adverse macroeconomic outcomes* dikemudian hari.

BAB 4
METODE PENELITIAN

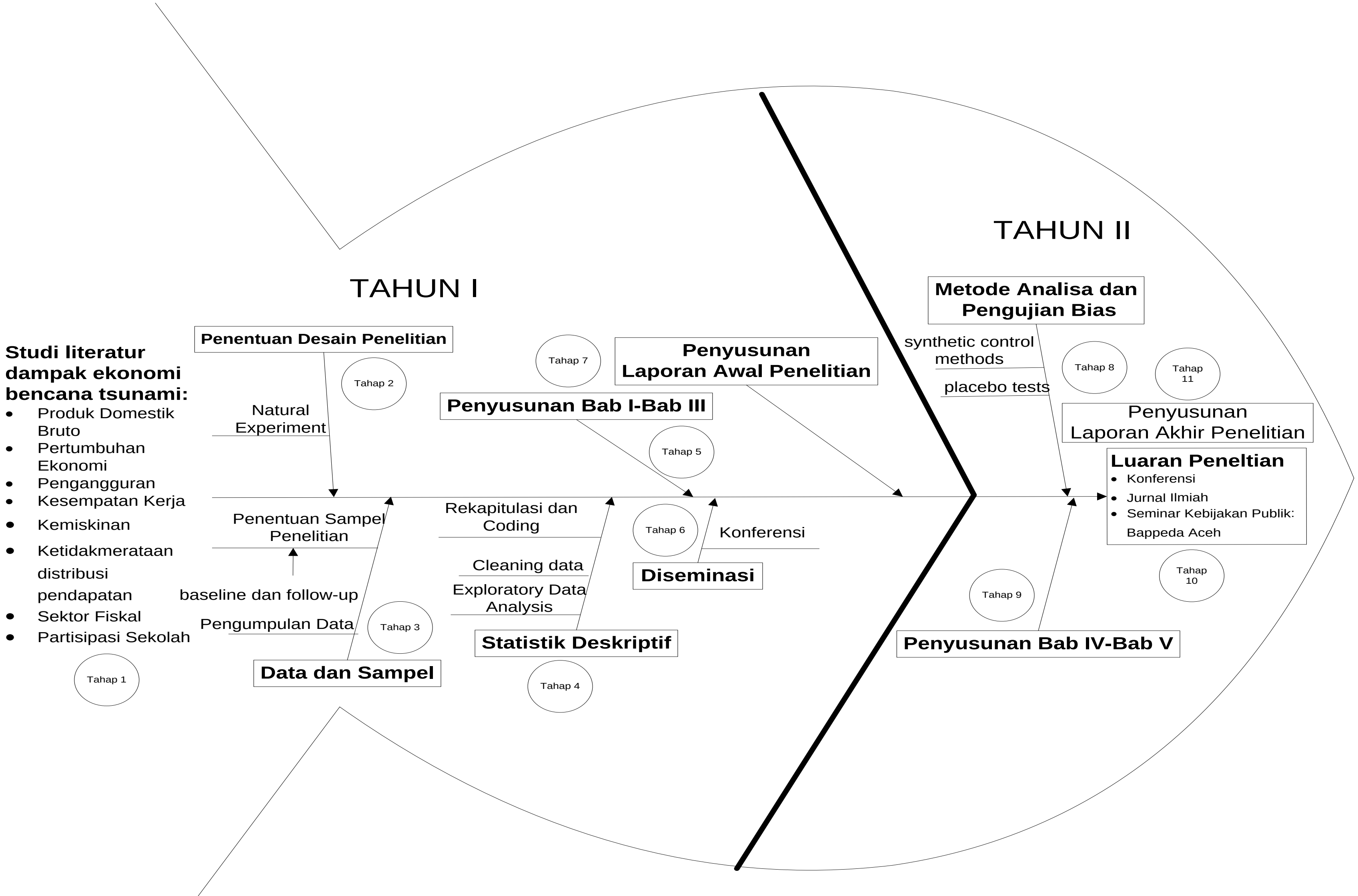
Penelitian ini merupakan salah satu bentuk evaluasi dampak kuantitatif (*quantitative impact evaluation*) yang berupaya untuk memberikan informasi kepada para pembuat kebijakan publik. Guna menghasilkan temuan yang *influential*, peneliti membutuhkan durasi waktu sekitar dua tahun untuk melengkapi tahap-tahap penelitian yang telah digariskan. Pada dasarnya, tahun pertama (tahun 2012) didedikasikan untuk mengumpulkan, membersihkan, dan mengolah data. Pada tahun kedua (tahun 2013), penelitian difokuskan untuk menginterpretasikan dan mendiseminasikan hasil-hasil penelitian. Ringkasan rencana pelaksanaan penelitian disajikan pada Gambar 3. Berdasarkan diagram ini, diketahui jika kegiatan penelitian terbagi menjadi sebelas tahapan utama. Berikut ini akan dielaborasikan masing-masing tahap penelitian yang akan diimplementasikan.

4.1. Tahap I: Studi Literatur

Pada tahap awal, peneliti melakukan studi literatur tentang dampak ekonomi dari bencana alam. Fokus utama peneliti adalah efek bencana alam terhadap variable-variabel yang akan diteliti, yaitu Produk Domestik Regional Bruto (PBRB), pertumbuhan ekonomi, pengagguran, kesempatan kerja, kemiskinan, ketimpangan pendapatan, sector fiskal, dan angka partisipasi sekolah.

4.2. Tahap II: Desain Penelitian

Desain penelitian ini dikenal sebagai eksperimen alamiah (*natural experiment*). Dengan mengadopsi eksperimen alamiah, peneliti tidak dapat memanipulasi *treatment* (yaitu bencana tsunami), sehingga desain ini meningkatkan validitas internal penelitian (Shadish *et al*., 2002). Dalam kalimat lain, inferensi tentang dampak tsunami terhadap kinerja perekonomian Provinsi Aceh memang benar-benar efek sesungguhnya dari bencana tsunami tersebut dan bukan diakibatkan oleh faktor-faktor perancu lain (*confounding factors*).



Gambar 2. Diagram alir penelitian evaluasi dampak bencana tsunami 2004 terhadap kinerja perekonomian provinsi Aceh

4.3. Tahap III: Sampel dan Data

4.3.1. Penentuan Sampel Penelitian

Evaluasi dampak yang *rigor* mensyaratkan penggunaan kombinasi *baseline data* dan *follow-up data*. Untuk mengakomodasi kebutuhan ini, peneliti menentukan *time span baseline data* adalah tahun 1995 - 2012 (sehingga peneliti dapat mengisolasi dampak Krisis Finansial Asia), sedangkan *follow-up data* adalah periode 2004-2012. Dari sampel untuk Indonesia: sejumlah 33 provinsi, kedudukan Provinsi Aceh adalah sebagai *treated unit*, sedangkan Provinsi-provinsi lain berpotensi sebagai *control unit*. Untuk Thailand: sejumlah 76 provinsi, kedudukan Provinsi Krabi, Phang Nga, Phuket, Ranong dan Trang adalah *treated unit*, sedangkan provinsi-provinsi lain berpotensi sebagai *control unit*.

4.3.2. Sumber Data

Sumber data yang akan digunakan dalam penelitian ini adalah sumber data sekunder. Data-data ini diperoleh dari Badan Pusat Statistik (BPS). Data-data makro-ekonomi yang dikumpulkan adalah data-data pada *level* provinsi (regional). Walapun beberapa data tersedia secara *online*, proses pengambilan data akan tetap dilakukan di BPS Pusat, dengan mempertimbangkan kelengkapan ketersediaan data. Untuk data Thailand, data tersedia secara *online*.

4.3.3. Definisi Operasional Variabel

Adapun definisi operasional dari variabel-variabel makroekonomi yang akan diakuisisi adalah:

- Pendapatan per kapita, dihitung dari rasio antara Produk Domestik Regional Bruto (PDRB) riil tahunan dibandingkan dengan jumlah penduduk.
- Pertumbuhan ekonomi, diukur dari perubahan Produk Domestik Regional Bruto (PDRB) riil tahunan.
- Angka Partisipasi Sekolah dipilah berdasarkan gender dan kelompok usia.

4.4. Tahap IV: Statistik Deskriptif

Data yang telah dikumpulkan dari BPS direkapitulasi dan dicoding, untuk memudahkan proses pengolahan data, termasuk proses *cleaning* data. Untuk mendapat-kan gambaran karakteristik awal dari data, peneliti juga melakukan *exploratory data analysis*.

4.5. Tahap V: Penyusunan Bab I-Bab III

Pada tahap ini, peneliti melengkapi beberapa bagian penelitian, yakni pendahuluan, kajian pustaka, dan metode penelitian.

4.6. Tahap VI: Diseminasi

Temuan awal penelitian didiseminasikan dengan mengikuti konferensi internasional. Masukan-masukan yang diterima selama konferensi diharapkan dapat menyempurnakan hasil penelitian.

4.7. Tahap VII: Penyusunan Laporan Awal Penelitian

Laporan Awal Penelitian diharapkan dapat menjadi bahan evaluasi peneliti tentang capaian kegiatan dan hasil penelitian, identifikasi permasalahan yang dihadapi, rencana penelitian kedepan, serta penyerapan anggaran.

4.8. Tahap VII: Metode Analisa dan Pengujian Bias

4.8.1. *Synthetic control method*

Penelitian ini menggunakan *synthetic control method*, untuk menjawab rumusan masalah diatas. Pada awalnya, *synthetic control method* diperkenalkan dan dipergunakan oleh Abadie dan Gardeazabal (2003) untuk mengestimasi dampak aktivitas terorisme ETA di Spanyol terhadap perekonomian Basque.

Asumsikan Y_{it} adalah variabel-variabel makroekonomi (selanjutnya disebut sebagai *outcome*) yang harus dievaluasi akibat bencana tsunami untuk Provinsi i ($i = 1$ untuk Provinsi Aceh, dan $i > 1$ untuk Provinsi-provinsi lain) dan waktu t (untuk periode waktu $t = 1, \dots T_0, \dots, T$; dimana T_0 adalah waktu terjadinya tsunami), sedangkan Y_{it}^I adalah *outcome* dari terjadinya tsunami dan Y_{it}^N adalah *outcome* seandainya tsunami tidak terjadi. Model ini mensyaratkan asumsi bahwa tsunami tidak memiliki dampak pada variabel-variabel makroekonomi tersebut sebelum waktu terjadinya bencana atau $T_0\left(Y_{it}^I Y_{it}^N < T_0\right)$.

Jika besaran-besaran makroekonomi yang dapat diobservasi dapat dinyatakan sebagai $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$, dimana α_{it} adalah dampak bencana tsunami terhadap variabel-variabel tersebut ($Y_{it}^I - Y_{it}^N$) dan D_{it} merupakan indikator *binary* yang menunjukkan kejadian bencana tsunami ($D_{it} = 1$ untuk $t \geq T_0$ dan $i = 1$; dan $D_{it} = 0$ untuk yang lainnya). Tujuan penelitian ini adalah untuk mengestimasi α_{it} pada saat $t \geq T_0$ untuk daerah yang terlanda tsunami ($i = 1$). Permasalahan identifikasi yang dihadapi adalah peneliti hanya dapat mengamati nilai Y_{it}^I bukan nilai Y_{it}^N pada saat $t \geq T_0$.

Walaupun tidak terdapat metode yang sepenuhnya akurat untuk menentukan Y_{it}, struktur perekonomian di Provinsi-provinsi di Indonesia adalah serupa dan *external shocks* yang mempengaruhi wilayah-wilayah ini (kecuali bencana tsunami) diasumsikan identik. Dengan asumsi-asumsi ini, Y_{1t} dapat dihitung sebagai rata-rata tertimbang dari observasi Y_{it} (untuk $i = 2, \ldots, J$) dari Provinsi-provinsi lain. Dengan demikian, $Y_{it}^N = \delta + \sum_{j=2}^{J} \omega_j Y_{jt}^N + \alpha_{1t} D_{1t} + \varepsilon_{1t}$. Untuk mengobservasi variabel-variabel makroekonomi sebelum terjadinya bencana ($t < T_0$), persamaan ini dapat diestimasi untuk mendapatkan penimbang yang dialokasikan untuk observasi-observasi dari Provinsi yang berbeda, ω_j.

Persamaan dibawah ini akan digunakan untuk mengobservasi variabel-variabel makroekonomi tersebut. Persamaan ini hanya mengandalkan observasi sebelum terjadinya bencana tsunami untuk mendapatkan estimasi parameter δ dan ω_j :

$$Y_{1t}^N = \delta + \sum_{j=2}^{J} \omega_j Y_{jt}^N + \varepsilon_{1t} \qquad (1)$$

Berdasarkan *Abadie et al*. (2010), estimasi terhadap α_{it} pada saat $t \geq T_0$ dapat dilakukan dengan menggunakan rumusan:

$$\hat{\alpha}_{it} = Y_{it}^I - \hat{Y}_{it}^N = Y_{it}^I - \left[\hat{\delta} + \sum_{J=2}^{J} \hat{\omega}_j Y_{jt}^N\right]$$

dimana besaran kedua disisi kanan persamaan (2) dihitung dengan menggunakan penimbang yang diestimasi ($\hat{\omega}_j$) yang diperoleh dari persamaan (1) dan observasi-observasi pasca bencana untuk setiap provinsi yang ada. Jadi, estimasi persamaan (1) hanya digunakan untuk mendapatkan *counterfactual*dari Provinsi Aceh dengan cara seakurat mungkin.

Bias yang dihasilkan dari *comparative case studies* dengan menggunakan *synthetic control* berasal dari bias yang terkait dengan kemampuan *post-treatmentsynthetic control* untuk mereplikasi *post-treatmentcounterfactual* pada observasi yang mendapatkan perlakukan. Penelitian ini menggunakan bencana *placebo* untuk menguji potensi bias yang dapat membahayakan hasil-hasil estimasi. Pengujian ini dilakukan dengan cara mengasumsikan bahwa Provinsi-provinsi lain yang dihantam bencana tsunami pada periode waktu yang sama. Bencana *placebo* ditujukan untuk menghasilkan *counterfactual synthetic control* dan untuk memeriksa distribusi prediksi pada kasus tidak terjadi bencana tsunami.

4.9. Tahap IX: Penyusunan Bab IV-Bab V

Pada tahap ini, data-data yang telah dianalisa diinterpretasikan, dampak ekonomi bencana tsunami diidentifikasikan berserta penjelasan naratifnya. Pelajaran dan rekomendasi kebijakan juga menjadi bagian integral tahap ini.

4.10. Tahap X: Luaran Penelitian

Kurangnya informasi dampak bencana alam, mengakibatkan kualitas perencanaan dan pelaksanaan perlindungan kepada para korban bencana alam menjadi tidak efisien, terutama bagi kelompok masyarakat yang rentan terhadap bencana alam. Hasil temuan penelitian ini diharapkan dapat memberikan informasi dan dimanfaatkan oleh penyelenggara negara, ketika mereformasi naskah akademik terkait dengan penyelenggaran sistem jaring pengaman sosial bagi korban bencana alam.

Guna memberikan kepastian bahwa hasil-hasil penelitian akan memberikan kontribusi dalam proses formulasi kebijakan publik, peneliti berkomitmen untuk mem-publikasikan dan mendiseminasikan temuan-temuan penelitian baik secara nasional maupun internasional pada jurnal-jurnal ilmiah terakreditasi, proceeding dan konferensi, sertaseminaryang bersifat *policy-oriented*.

Berikut adalah target diseminasi hasil penelitian:

Jurnal Ilmiah:

1. International Journal of Applied Mathematics and Statistics (Submitted)

Konferensi:

1. International Conference on Statistics and Mathematics (ICSM 2014), Surabaya November 2014 (Accepted)
2. The 5^{th} International Conferences on Aceh and Indian Ocean Studies, Banda Aceh, 17-18 Novmber 2014 (Accepted)

4.11. Tahap XI: Penyusunan Laporan Akhir Penelitian

Pelaksanaan kegiatan penelitian diakhiri dengan penyusunan Laporan Akhir Penelitian.

BAB 5
HASIL YANG DICAPAI

5.1. Deskripsi Data

Penelitian ini mengkaji dampak dari bencana alam, yakni tsunami yang terjadi pada 26 Desember 2004 di wilayah-wilayah yang berada di tiga Negara yaitu, Indonesia, Thailand dan Srilanka, terhadap pertumbuhan ekonomi jangka pendek dan jangka panjang. Wilayah-wilayah tersebut adalah: Aceh di Indonesia, Krabi, Phang Nga, Phuket, Ranong, dan Trang di Thailand, serta Talwatta di Srilanka. Pada penelitian ini akan digali dampak tsunami terhadap pertumbuhan ekonomi di Indonesia dan Thailand.

Adapun metode yang digunakan adalah metode desain experimental dengan menempatkan wilayah-wilayah tersebut sebagai *experimental unit* dan provinsi-provinsi lain sebagai *control units*. Analisa ini menggunakan kumpulan data PDRB beserta predictornya dari Badan Pusat Statistik (BPS), *National Statistical Office* (NSO) *of Thailand*, dan *National Economic and Social Development Board* (NESDB) *of Thailand*. Penelitian ini menggunakan data tahun 1995 hingga 2012.

Berdasarkan desain awal penelitian, maka dilakukan kajian terhadap provinsi-provinsi yang memenuhi syarat sebagai sampel penelitian. Untuk Indonesia: sampel utama diambil dari Provinsi Aceh yang merupakan obyek penelitian utama, selanjutnya dipilih dua puluh lima (25) provinsi lain yang merupakan provinsi-provinsi yang telah ada sejak tahun 1995 dan tidak berubah komposisi daerahnya hingga tahun 2012. Hal ini akan memudahkan proses seleksi terhadap pengambilan provinsi yang dianggap sebagai *control unit* bagi Provinsi Aceh. Demikian pula berlaku untuk Thailand yang terdiri dari 76 provinsi, dengan memperlakukan Provinsi Phang Nga sebagai *treated unit*.

Data yang digunakan dalam penelitian ini secara umum adalah pertumbuhan ekonomi dan diukur dengan menggunakan *Gross Regional Domestic Product* (GRDP) per kapita, dan beberapa prediktor dari pertumbuhan ekonomi yang meliputi:

- Sektor-sektor yang cukup memegang peranan penting bagi pertumbuhan dan peningkatan nilai ekonomi seperti pertanian, mining, manufaktur, konstruksi, utilitas, perdagangan, hotel dan restauran, transportasi dan komunikasi, keuangan dan jasa.
- Variabel investasi seperti pertumbuhan rata-rata dari pembentukan model.
- Jumlah partisipasi sekolah baik dari tingkat SD, SMP, SMA, dan Universitas.
- Jumlah penduduk.

5.2. Gambaran Umum Penelitian

5.2.1 Gambaran Umum Indonesia

Berdasarkan 26 provinsi yang diambil, maka Aceh akan dijadikan sebagai sentral pengamatan, dimana dengan menggunakan uji beda berpasangan, akan dilihat seberapa berbeda provinsi Aceh dari dua puluh lima (25) provinsi lainnya dalam sektor-sektor pertumbuhan ekonomi. Untuk mendapatkan gambaran jelas, akan dibagi tahun pengamatan dalam dua bagian, yakni sebelum terjadi tsunami dan sesudah terjadi tsunami.

Sebelum terjadinya tsunami, GRDP Aceh terhadap 25 provinsi lainnya berbeda secara signifikan, sedangkan setelah terjadi Tsunami GRDP Aceh tidak berbeda signifikan dengan Sumatera Barat dan Lampung (Lampiran A: Tabel A1).

Pada bidang pendidikan dan angka melek huruf, tingkat partisipasi Sekolah Dasar di Aceh berbeda secara signifikan dengan provinsi lainnya, baik sebelum dan sesudah terjadinya tsunami (Lampiran A: Tabel A2). Pada tingkat SMP sebelum tsunami di Aceh berbeda secara signifikan dengan hampir seluruh provinsi kecuali Riau dan D.I. Yogyakarta, sedangkan setelah tsunami, tingkat partisipasi sekolah SMP tidak berbeda dengan Sumatera Barat dan Nusa Tenggara Timur (Lampiran A: Tabel A3). Di tingkat SMA, kondisi Aceh sebelum tsunami mirip dengan tingkat SMP, dimana secara statistik tidak berbeda signifikan dengan provinsi Riau sedangkan setelah tsunami berbeda secara signifikan dengan semua provinsi (Lampiran A: Tabel A4). Di tingkat Universitas, kondisi Aceh secara statistik berbeda signifkan dengan semua provinsi sebelum terjadinya tsunami, namun pasca tsunami kondisi ini berubah dimana tingkat partisipasi sekolah jenjang Universitas tidak berbeda signifikan dengan Sumatera Barat dan Sumatera Selatan (Lampiran A: Tabel A5). Jika dilihat dari tingkat/ jumlah masyarakat yang melek huruf sebelum terjadinya tsunami, kondisi Aceh tidak berbeda secara signifikan dengan Sumatera Selatan, Bengkulu, Jawa Barat, Kalimantan Selatan, Sulawesi Tengah, dan Maluku. Sedangkan setelah terjadi tsunami, kondisi Aceh tidak berbeda dengan Jambi, Bengkulu, Lampung, dan Sulawesi Tengah (Lampiran A: Tabel A6).

Adapun dampak tsunami untuk sektor-sektor yang sangat berhubungan dengan penciptaan nilai tambah dari pertumbuhan ekonomi daerah seperti halnya sektor pertanian, pertambangan, kegiatan produksi secara deskriptif dapat diuraikan sebagai berikut.

Dalam sektor pertanian, sebelum tsunami, kondisi Aceh nyaris berbeda signifikan dengan 25 provinsi lain kecuali Riau dan Lampung. Sedangkan setelah tsunami, kondisi Aceh tidak berbeda signifikan dengan Sumatera Barat dan Riau (Lampiran A: Tabel A7).

Di sektor Pertambangan (Lampiran A: Tabel A8) kondisi Aceh sebelum tsunami tidak berbeda signifikan dengan Jawa Barat dan Papua. Sedangkan setelah tsunami kondisi Aceh tidak berbeda dengan Jawa Barat, Jawa Timur, Nusa Tenggara Barat, Kalimantan Selatan dan Sulawesi Selatan.

Dari sisi kegiatan industry (Lampiran A: Tabel A9) sebelum tsunami, kondisi Aceh berbeda signifikan dengan 25 provinsi lainnya, namun pasca tsunami, kondisi manufaktur di Aceh tidak berbeda dengan Sumatera Barat, Lampung dan Kalimantan Barat.

Kondisi Aceh dengan 25 provinsi lain, dilihat dari besaran kebutuhan utilitas yang tersedia (Lampiran A: Tabel A10). Jika diamati, sebelum tsunami kondisi Aceh tidak berbeda signifikan dengan Sulawesi Tengah, namun setelah tsunami kondisi Aceh terlihat berbeda signifikan dari semua provinsi. Nilai rata-rata negatif mengindikasi kondisi Aceh yang jauh lebih kecil daripada provinsi bandingan.

Pada sektor bangunan dan kontruksi (Lampiran A: Tabel A11) kondisi Aceh sebelum tsunami nyaris berbeda dengan seluruh provinsi, kecuali dengan Lampung dan Sulawesi Selatan. Setelah tsunami melanda, kondisi Aceh tidak berbeda signifikan dengan Papua. Sedangkan pada sektor perdagangan, hotel dan restauran (Lampiran A: Tabel A12) sebelum tsunami hampir semuanya berbeda signifikan dengan antara Aceh dengan 25 provinsi lainnya, kecuali Jawa Timur. Setelah tsunami melanda, terlihat bahwa kondisi Aceh tidak berbeda signifikan dengan daerah Kalimantan Barat.

Kemudian, jika dikaji dari sektor Pengangkutan dan Komunikasi (Lampiran A: Tabel A13) sebelum tsunami, Aceh memiliki karakteristik yang tidak berbeda dengan Riau, Sumatera Selatan, dan Sulawesi Selatan dalam sektor Pengangkutan dan Komunikasi. Setelah tsunami terjadi, posisi ini agak bergeser, dimana kondisi Aceh tidak berbeda signifikan dengan Lampung, Kalimantan Barat, dan Sulawesi Selatan.

Pada sektor Keuangan, Real Estate dan Jasa Perusahaan (Lampiran A: Tabel A14), Aceh tidak berbeda signifikan dengan Jambi, NTB, NTT, Kalimantan Tengah, Maluku dan Papua sebelum tsunami terjadi. Sedangkan setelah tsunami Aceh kondisi sektor ini nyaris berbeda dari semua provinsi kecuali dengan Sulawesi Tenggara dan Papua. Perubahan nilai rata-rata yang semakin negatif setelah tsunami memberi informasi bahwa sektor ini menerima dampak yang cukup parah dari tsunami.

Pada sector jasa-saja (Lampiran A: Tabel A15), provinsi Lampung dan Kalimantan Barat tidak berbeda signifikan dari Aceh sebelum tsunami, sedangkan setelah tsunami terlihat bahwa provinsi Riau, Sumatera Selatan dan Sulawesi Selatan yang tidak memiliki perbedaan signifikan dengan Aceh.

Dilihat dari jumlah penduduk, jumlah provinsi Aceh berbeda signifikan dari seluruh provinsi di Indonesia sebelum tsunami (Lampiran A: Tabel A.16), sedangkan setelah tsunami terdeteksi bahwa provinsi Kalimantan Barat tidak memiliki perbedaan signifikan dalam jumlah penduduk dengan Aceh.

5.2.2 Gambaran Umum Thailand

Phuket dan Krabi adalah provinsi di Selatan Thailand, bertetangga dengan Phang Nga. Kedua provinsi ini adalah daerah pariwisata. Trang dan Ranong merupakan daerah penghasil Karet. Ranong merupakan provinsi yang memiliki populasi paling sedikit di Thailand dan merupakan daerah yang padat dengan hutan. Satun adalah wilayah Thailand yang berbatasan dengan Malaysia dengan mayoritas penduduknya adalah muslim.

Phang Nga adalah salah satu dari provinsi-provinsi selatan dari Thailand. Provinsi ini terletak di sisi barat Semenanjung Melayu, dan mencakup banyak pulau-pulau di Phang Nga Bay, yang sering disebut James Bond Island. Phang Nga terletak 788 kilometer dari Bangkok dan meliputi area seluas 4.170 kilometer persegi, luas area ini menduduki peringkat ke 53 dari 76 provinsi di Thailand. Termasuk daerah yang rendah populasi, yaitu 254.931 penduduk dan menduduki ke 71 dari 76 provinsi. Sehingga tidak mengherankan jika pengeluaran di hampir semua sektor selalu berada jauh di bawah rata-rata pengeluaran semua propinsi (Lihat Lampiran B).

Pada pagi hari 26 Desember 2004 provinsi-provinsi ini hancur oleh bencana Tsunami dan ribuan orang kehilangan nyawa mereka.

5.3 Hasil Penelitian

5.3.1 Hasil *Synthetic Control Method* untuk Aceh

Kajian penelitian ini dimulai dengan membandingkan rata-rata pertumbuhan PDRB per kapita dari setiap 25 provinsi (*control unit*) terhadap experimental unit, dimana dalam hal ini adalah Aceh. Hasil ini memberikan indikasi bahwa DKI Jakarta dan Kalimantan Timur memiliki karakteristik PDRB yang sangat jauh bila dibandingkan dengan PDRB dari Aceh. Untuk itu kedua daerah tersebut tidak diikutsertakan sebagai candidat daerah *synthetic* bagi Aceh.

Tabel 2 memberikan gambaran tentang kondisi perekonomian secara rata-rata baik di Aceh, daerah synthetic dan seluruh provinsi sebelum tsunami terjadi. Dalam perbandingan ini digunakan log PDRB yang menggambarkan nilai pertumbuhan dari

PDRB. Digunakan tiga tahun pengamatan yaitu tahun 1995 sebagai initial PDRB, sebelum krisis terjadi di tahun 1996 dan sebelum implementasi Otonomi Daerah tahun 2000. Untuk sektor-sektor pertumbuhan ekonomi yang lain, dilakukan perhitungan dari tahun 1995-2004. Terlihat pada tabel tersebut nilai PDRB dari Aceh dan daerah *synthetic*-nya sangatlah mirip.

Selanjutnya dengan menggunakan *synthetic control method* (SCM) dicari nilai bobot yang akan menunjukkan seberapa dekat nilai PDRB dari Aceh terhadap daerah *synthetic* tersebut. Berdasarkan hasil estimasi, PDRB Aceh secara synthetic dapat dinyatakan sebagai kombinasi linear dari 4 provinsi lain, yaitu 63,6% PDRB Riau; 0,1% PDRB DI Yogjakarta; 17% PDRB Kalimantan Tengah dan 19,3% PDRB Maluku. Secara matematis dapat dituliskan:

PDRB _Aceh = 0,636 PDRB _Riau + 0,001PDRB _DIYogjakarta + 0,17 PDRB _ Kalimantan Tengah + 0,193 PDRB _Maluku.

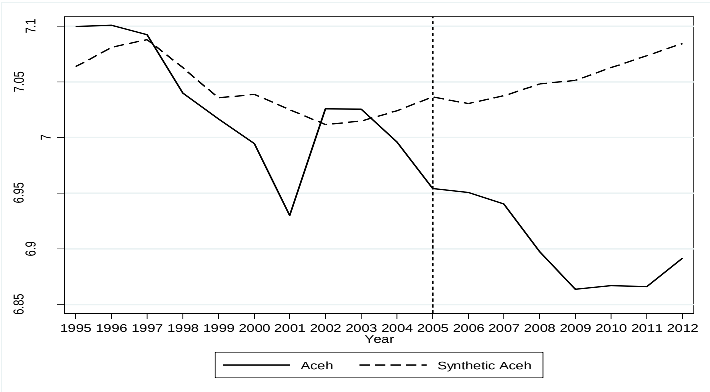
Tabel 2. Prediksi PDRB antara Aceh dan daerah-daerah synthetic

	Treated	Synthetic	Sampel Mean
lPDRB_Cap(1995)	7,09968	7,06357	6,64604
lPDRB_Cap(1996)	7,10064	7,08085	6,67211
lPDRB_Cap(2000)	6,99456	7,03874	6,67301
depth	5,55538	10,14637	14,13818
ldensity	1,84252	1,52835	2,01097
sagri	20,22376	18,83451	9,71518
smin	28,89848	33,92403	9,71518
sman	24,77080	16,25372	14,94520
sutil	0,18038	0,38191	0,84896
scons	4,13342	3,31112	5,88900
strad	8,40357	12,72664	16,89862
strans	5,50490	4,83702	7,97817
sfin	0,95327	3,44438	4,78184
sserv	6,93141	6,28664	11,92798
primary	96,40857	96,25080	94,53515
junior	82,22571	83,12846	78,17577
senior	52,68714	51,55873	49,11934
univ	13,03429	9,90935	11,94736
literacy	93,27000	95,66445	89,62000

Terlihat bahwa SCM memberikan bobot yang sangat besar pada provinsi Riau. Hal ini tidaklah mengherankan, karena struktur ekonomi Aceh dan Riau sangatlah tergantung pada minyak dan gas bumi selama periode pengambilan data.

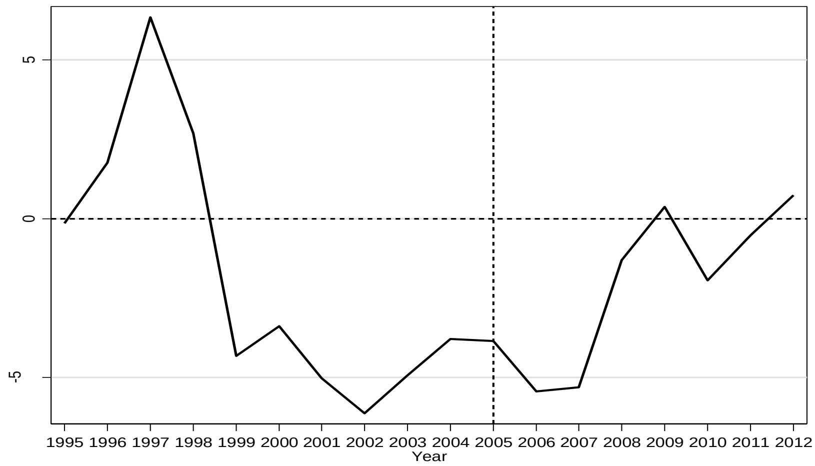
Untuk memberikan gambaran yang jelas, Gambar 3 menampilkan dinamika PDRB per capita bagi Aceh dan daerah *synthetic*-nya dari tahun 1995-2012. Kedua *plot series* tersebut tidak memberikan perbedaan yang sangat jauh hingga tahun 2004. Pada selang waktu 1995-2004, terjadi perbedaan yang tajam pada tahun 2001 dan 2002. Hal ini terjadi karena adanya share minyak dan gas di Aceh mengalami pelonjakan dua kali lipat di tahun itu.

Berdasarkan Gambar 3, kondisi perekonomian Aceh dan daerah *synthetic* sebelum terjadi tsunami adalah mirip. Setelah tsunami melanda Aceh di tahun 2004 terlihat sangat jelas gap pertumbuhan ekonomi antara Aceh dan daerah *synthetic* tersebut. Dengan demikian dapat dikatakan bahwa tsunami memberikan dampak ekonomi yang sangat besar bagi pertumbuhan Aceh. Andaikan tsunami tidak terjadi di Aceh, maka dapat dilihat bahwa pertumbuhan ekonomi Aceh tersebut memiliki tren yang positif.



Gambar 3. Prediksi PDRB _Cap antara Aceh dan Daerah-daerah Synthetic

Untuk melihat dampak dari bencana ini secara ekonomi Gambar 4 menunjukkan bahwa PDRB *per capita* dari Aceh menurun secara tajam. Apabila tsunami tidak terjadi, PDRB Aceh di tahun 2005 akan menurun sebesar 3,85%. Nilai PDRB pada Gambar 3 merupakan nilai PDRB yang dinyatakan dalam bentuk logaritma, sedangkan untuk menghitung % gap PDRB pada Gambar 4, nilai tersebut sudah di antilogaritmakan. Gap pada Gambar 4 dihitung dengan cara: gap PDRB = (PDRB_treated-PDRB_synthetic) / PDRB_synthetic



Gambar 4. Persentase *gap* PDRB antara Aceh vs. Synthetic Aceh

5.3.2 Hasil *Synthetic Control Method* untuk Phang Nga

Kajian penelitian ini dimulai dengan membandingkan rata-rata pertumbuhan PDRB per kapita dari setiap 75 provinsi (*control unit*) terhadap experimental unit, dimana dalam hal ini adalah Phang Nga.

Tabel 3. memberikan gambaran tentang kondisi perekonomian secara rata-rata baik di Phang Nga, daerah synthetic dan seluruh provinsi sebelum tsunami terjadi. Dalam perbandingan ini digunakan log PDRB yang menggambarkan nilai pertumbuhan dari PDRB. Untuk sektor-sektor pertumbuhan ekonomi yang lain, dilakukan perhitungan dari tahun 1995-2004. Terlihat pada tabel tersebut nilai PDRB dari Phang Nga dan daerah *synthetic*-nya sangatlah mirip.

Selanjutnya dengan menggunakan *synthetic control method* (SCM) dicari nilai bobot yang akan menunjukkan seberapa dekat nilai PDRB Phang Nga terhadap daerah *synthetic* tersebut (lihat Lampiran C). PDRB Phang Nga secara synthetic dapat dinyatakan sebagai kombinasi linear dari 5 provinsi lain, yaitu 3,7% PDRB Chumphon; 22,7% PDRB Kalasin; 56,6% PDRB Kamphaeng Phet; 14% PDRB Nong Khai; 12,4% Sing Buri; 0,3% PDRB Sukhotai; 0,1% Suphan Thani; 3,9% PDRB Trat. Terlihat bahwa SCM memberikan bobot yang sangat besar pada provinsi Kamphaeng Phet.

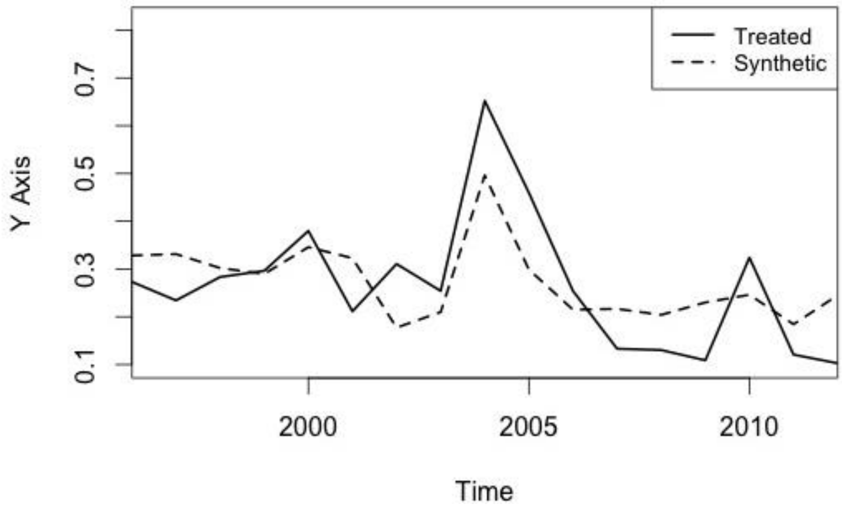
Tabel 3. Prediksi PDRB antara Phang Nga dan daerah-daerah synthetic

	Treated	Synthetic	Sample Mean
silletracy	3,859	4,000	4,652
skinder	40,327	40,542	44,223
sprimary	25,199	25,069	22,400
sjunior	11,811	12,198	12,061
ssenior	9,132	8,950	8,173
suniv	9,004	8,918	8,314
special.PDRB_Cap.1996.2004	4,882	4,725	4,668
special.sagri.1996.2004	48,304	35,911	20,939
special.sman.1996.2004	4,871	15,936	19,084
special.sutil.1996.2004	1,318	1,544	2,429
special.scons.1996.2004	2,184	3,538	4,999
special.strade.1996.2004	12,583	12,657	12,644
special.stourism.1996.2004	2,866	1,037	1,969
special.strans.1996.2004	4,375	4,420	4,421
special.sfin.1996.2004	2,571	2,909	3,938
special.shousing.1996.2004	4,706	4,266	6,086
special.spublic.1996.2004	8,027	7,308	9,100
special.sedu.1996.2004	4,333	7,454	8,206
special.shealth.1996.2004	1,443	1,486	2,253
special.sserv.1996.2004	0,885	0,931	1.377
special.shh.1996.2004	0,322	0,311	0.33
special.Density.1996	54,644	132,152	163.144

Kombinasi linear tersebut, secara matematis dapat dituliskan sebagai berikut:

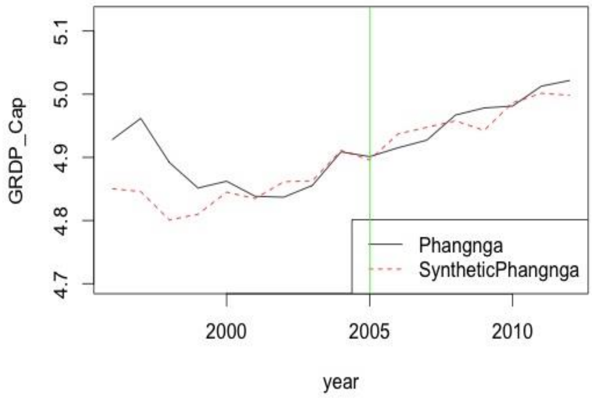
PDRB_PhangNga = 0,370 PDRB _Chumphon + 0,227 PDRB _Kalasin +
0,566 PDRB _KamphaengPhet + 0.014 PDRB _NongKhai+
0,124 PDRB _SingBuri+0.003 PDRB _Sukhotai+
0,001 PDRB _SuphanThani + 0,039 PDRB _Trat

Untuk memberikan gambaran yang jelas, Gambar 5 menampilkan dinamika PDRB per kapita bagi Phang Nga dan daerah *synthetic*-nya dari tahun 1995-2012. Kedua *plot series* tersebut tidak memberikan perbedaan yang sangat jauh. Hal ini menunjukkan bahwa efek Tsunami di daerah Phang Nga dapat segera di atasi.



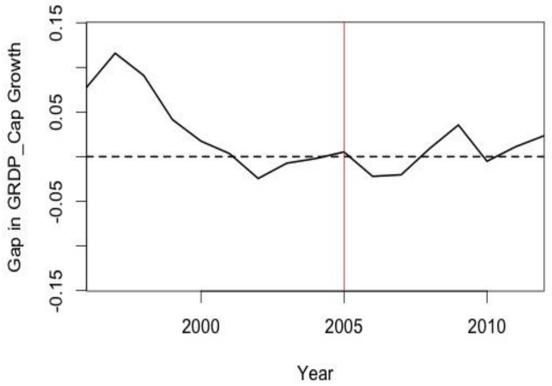
Gambar 5. Prediksi PDRB_Cap antara Phang Nga dan Daerah-daerah Syntheticnya

Terlihat pada Gambar 6 kondisi perekonomian Phang Nga dan daerah *synthetic* sebelum terjadi tsunami adalah mirip. Setelah tsunami melanda Phang Nga di tahun 2004 gap pertumbuhan ekonomi antara Phang Nga dan daerah *synthetic* tersebut tidaklah terlalu besar.



Gambar 6. Tren per-capita PDRB: Phang Nga vs. Synthetic Phang Nga

Berdasarkan Gambar 7, dapat disimuplkan bahwa tsunami tidak menimbulkan gejolak bagi PDRB Phang Nga. Gap PDRB antara Phang Nga dan daerah-daerah syntheticnya sangat kecil.



Gambar 7. Persentase *gap* PDRB antara Phang Nga vs. Synthetic Phang Nga

5.4 Studi tentang Placebo

Tidak seperti halnya pada metode-metode statistik lain, hingga saat ini SCM belum memiliki teknik inferensi baku. Untuk mengatasi keterbatasan ini, Abadie *et al*. (2010) mengusulkan untuk menggunakan metode alternatif yang didasarkan pada studi *placebo*. Pada studi ini, *placebo* tidak akan memberikan respon terhadap data apabila intervensi yang dilakukan adalah intervensi yang salah. Hal ini berbeda bila intervensi yang salah itu diberikan pada unit intervensi yang sesungguhnya. Untuk itu, pada studi-studi *placebo* ini akan dilakukan beberapa percobaan untuk menguji berlakunya asumsi-asumsi yang mendasari SCM.

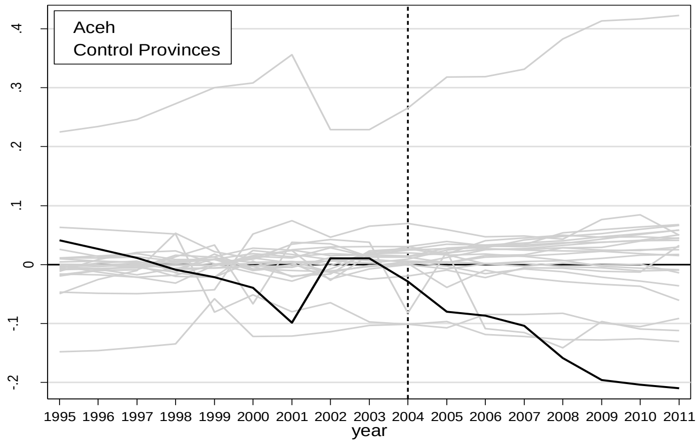
Uji Placebo yang dituliskan secara detail pada makalah ini adalah uji Placebo untuk Aceh, sedangkan hasil Uji Placebo untuk daerah-daerah yang terlanda tsunami di Thailand dapat dilihat di Lampiran D

5.4.1 Uji *Placebo* di antara *untreated unit*

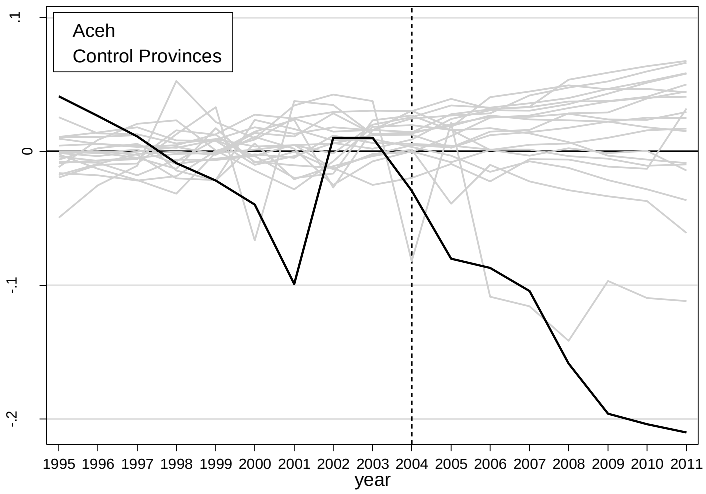
Salah satu cara untuk mengevalusi signifikansi *treatment* effect adalah dengan cara mencari ulang daerah *synthetic* yang sebelumnya hanya dianggap sebagai *control unit.* Cara ini dilakukan dengan menganggap satu *control unit* sebagai *treated unit* dan *control unit* ini diperlakukan seolah-olah mengalami tsunami pada tahun yang sama, seperti pada saat tsunami terjadi di Aceh, yaitu tahun 2004.

Gambar 8 menggambarkan hasil uji *placebo* ini. Pada Gambar 7 tersebut terdapat satu daerah yang mencuat jauh di atas (memiliki *root mean square prediction error* – RMSPE 2 kali lebih tinggi dari RMSPE Aceh). Daerah tersebut adalah Papua. Untuk menghindari bias dalam studi *placebo* ini, maka daerah tersebut dibuang dari analisa (Gambar 9)

Perbedaan pada PDRB per kapita antara Aceh dan daerah *synthetic*-nya digambarkan dengan garis lurus hitam di Gambar 8, sedangkan untuk daerah *placebo* yang lain digambarkan dengan garis abu-abu pada Gambar 8. Terlihat bahwa tsunami benar-benar memberikan efek tidak diharapkan pada Aceh, dan tidak pada daerah *placebo* yang lain.



Gambar 8. *Gap* GRDP *per capita* antara Aceh dan provinsi *placebo*

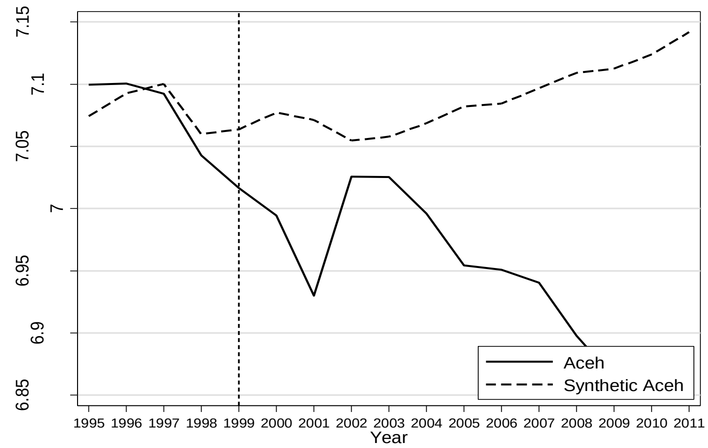


Gambar 9. *Gap* GRDP *per capita* di Aceh dan provinsi *placebo*
(provinsi dengan RMSPE 2x lebih tinggi dari RMSPE Aceh di keluarkan)

5.4.2 Uji *Placebo* dalam waktu

Untuk menguji signifikansi dari waktu, maka dilakukan uji *placebo* terhadap waktu, dengan memindahkan waktu tsunami (periode waktu *treatment*), bila waktu tersebut digeser bukan di tahun 2004 melainkan sebelumnya, yakni tahun 1999. Pemilihan waktu treatment 1999 ditujukan untuk menghindari pontensi efek penggangu (*confounding* *effects*) dari gonjangan-gonjangan yang lain, yaitu terjadinya krisis ekonomi dan implementasi otonomi daerah.

Gambar 10 memberikan ilustrasi apabila tsunami terjadi di tahun 1999 (lima tahun dari kejadian sesungguhnya). Terlihat bahwa bila tahun tersebut digeser efek tsunami sebelum antara tahun 1995-1999 tidaklah terlihat. Lain halnya bila efek tsunami tersebut dilihat dari tahun 2005 ke atas.

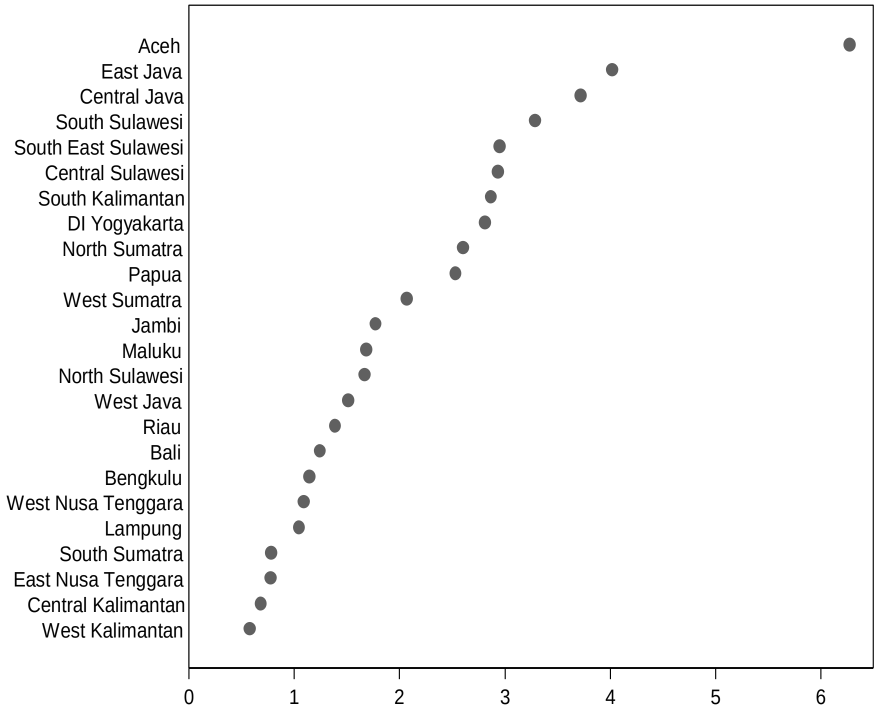


Gambar 10. GRDP *per capita* di Aceh dan provinsi *placebo* (bila *placebo* tsunami terjadi di tahun 1999)

5.4.3 Uji keekstriman pada *treatment* (*Treatment Extremity Tests)*

Untuk melihat ketangguhan dari model estimasi yang telah diberikan di atas, maka perlu uji keekstriman *treatment*, melalui besaran perbandingan RMSPE antara sesudah dan sebelum tsunami terjadi. Gambar 10 menunjukkan bahwa nilai perbandingan RMSPE bagi Aceh sangat berbeda bila dibandingkan dengan provinsi-provinsi lain yang menjadi *control* dalam analisa ini. Bagi Aceh RMSPE setelah tsunami 6,27 kali dari RMSPE sebelum tsunami. Hal ini sangat kontras bila dibandingkan dengan provinsi-provinsi lain yang memiliki rasio antara 0,5 hingga 4,00 saja.

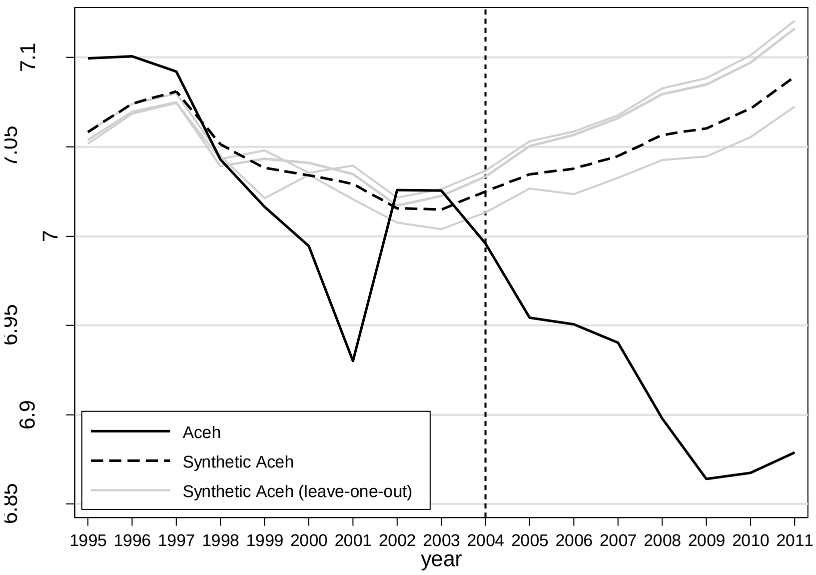
Hal ini dapat pula diartikan, andaikan tsunami itu terjadi pada provinsi lain yang dipilih secara acak, maka probabilitas untuk mendapatkan efek negatif dan nilainya sangat besar pada PDRB *per capita* sebagaimana ditunjukkan oleh Aceh adalah 1/24 atau sekitar 4%. Seperti dalam analisa regresi biasa, maka bila kita mematok tingkat signifikansi sebesar 5%, maka dapat dikatakan bahwa kita menolak hipotesa nol, dan menyatakan bahwa tsunami Aceh memberikan dampak yang signifikan dan negatif pada PDRB per capita provinsi ini.



Gambar 11. Rasio RMSPE antara Aceh dan Kontrol Provinsi pada periode setelah and sebelum-tsunami

5.4.4 *Leave-One-Out Tests*

Seperti dipaparkan sebelumnya, synthetic unit adalah kombinasi linear dari beberapa *control unit* yang menyerupai *treated unit*. Jadi, *synthetic control unit* tidak hanya ditentukan oleh satu *control unit* saja. *Leave-one-out tests* adalah metode yang digunakan untuk menguji hal ini. Pada prakteknya, *leave-one-out tests* dilakukan dengan cara mengeluarkan satu per satu provinsi yang terpilih menjadi *synthetic control* Aceh, dan hasil estimasi dari proses iterasi ini dibandingkan dengan hasil estimasi yang menggunakan seluruh *syhthetic province* yang terpilih. Gambar 12 memberikan hasil dari *leave-one-out tests*. Terlihat bahwa bila satu persatu control unit dikeluarkan dari model estimasi, hasilnya tidak menunjukkan perubahan yang signifikan terhadap daerah synthetic yang telah terpilih. Hal ini menunjukkan bahwa daerah synthetic yang terpilih tidak hanya dipengaruhi oleh satu provinsi saja dan hasil ini tidak bias.



Gambar 12. *Leave-One-Out Tests*

5.5. Studi Perbandingan antara (Aceh) Indonesia dan (Phuket, Krabi, Phang Nga, Trang, Ranong dan Satun) Thailand

Analisa gap PDRB untuk setiap provinsi yang terkena dampak Tsunami beserta daerah syntheticnya, menunjukkan bahwa di tahun 2005, PDRB Aceh 16,24% lebih rendah bila dibandingkan dengan provinsi-provinsi sintetiknya dan secara rata-rata PDRB Aceh 27,02% lebih rendah bila dihitung sejak tsunami terjadi. Bila dibandingkan dengan Phuket di Thailand, di tahun 2005, PDRB Phuket 21,95% lebih rendah bila dibandingkan dengan provinsi-provinsi sintetiknya, namun secara rata-rata PDRB Phuket PDRB ini hanya turun 3,08% bila dihitung sejak tsunami terjadi. Hal ini menunjukkan perbaikan ekonomi di Phuket jauh lebih cepat bila dibandingkan dengan Aceh.

Secara umum dapat dikatakan bahwa percepatan pemulihan perekonomian Thailand lebih cepat bila dibandingkan dengan Indonesia. Hal ini dapat dilihat, bahwa secara rata-rata penurunan PDRB per capita Indonesia pada selang waktu (2005-2012) mengalam penurunan sebesar 10,36%, sedangkan Thailand hanya -1,17%. Penurunan yang dimaksudkan di sini adalah perbandingan antara nilai PDRB Indonesia per capital secara nyata, dan seandainya Indonesia tidak terkena Tsunami (*synthetic control*). Hal yang sama pula untuk Thailand (Tabel 4).

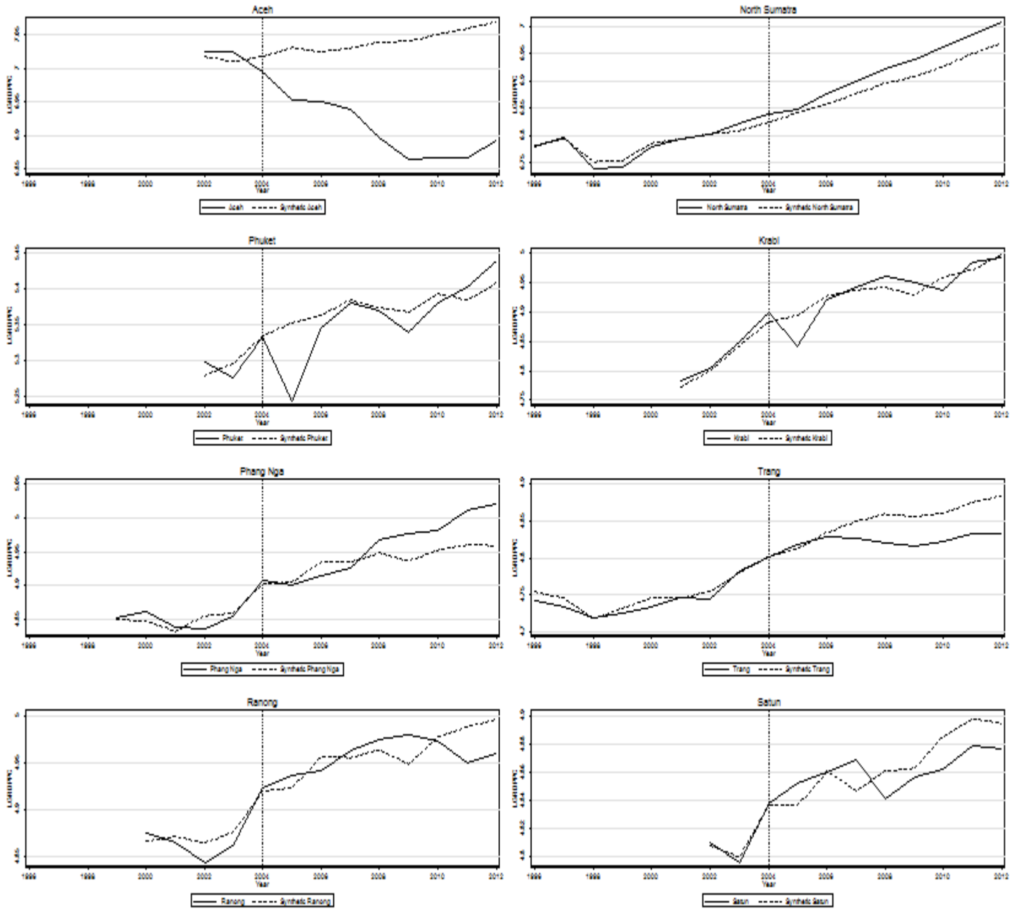
Hal ini dapat dipahami, karena wilayah Thailand yang terkena Tsunami utamanya adalah daerah Pariwisata.

Perbandingan log dari PDRB per capita untuk untuk masing-masing provinsi yang terkena dampak tsunami beserta synthetic control unitnya dapat dilihat pada Gambar 13.

Tabel 4. Ringkasan dampak Tsunami bagi Indonesia dan Thailand

	2005		Rerata	
	Gap	%	Gap	%
Indonesia	-816,21	-7,31	-1.245,45	-10,36
Aceh	-1,744,82	-16,24	-3.014,25	-27,02
North Sumatra	112,40	1,62	523,36	6,30
Thailand	-9,285,87	-4,98	-1.534,04	-1,17
Phuket	-49,445,71	-21,95	-6.757,41	-3,08
Krabi	-8,863,03	-11,31	-446,27	-0,63
Phang Nga	-732,29	-0,91	4.797,00	5,30
Trang	988,23	1,52	-4.773,15	-6,48
Ranong	2,392,44	2,86	-921,82	-0,80
Satun	-54,84	-0,08	-1.102,58	-1,34

Catatan: Gap adalah nilai perbedaan PDRB per capita antara provinsi yang diamati dan daerah sintetiknya (dalam 1000 Rp untuk Indonesia dan 1000 Baht untuk Thailand. % adalah ratio dari Gap PDRB per capita dari synthetic control. Rerata adalah rata-rata yang diambil dalam kurun waktu setelah Tsunami hingga Tahun 2012.



Gambar 13. Log PDRB per capita: Provinsi yang terkena tsunami dan synthetic control units

BAB 6
KESIMPULAN

Pada tahap ini diberikan hasil studi antara daerah Aceh di Indonesia dan Phuket, Krabi, Phang Nga, Phang Nga, Trang, Ranong dan Satun di Thailand setelah dilanda tsunami 2004. Studi komparasi antara seluruh wilayah yang dilanda tsunami antara Indonesia dan Thailand telah dilakukan dengan menggunakan Synthetic Control Methods. Menggunakan metode ini dapat ditunjukkan bahwa Tsunami memberikan dampak negative terhadap pertumbuhan ekonomi (PDRB per capita) di provinsi-provinsi yang terlanda tsunami.

Selain itu, studi perbandingan antara Indonesia dan Thailand menunjukkna bahwa Thailand lebih cepat pulih bila dibandingkan dengan Indonesia. Salah satu penyebab yang ditengarai adalah provinsi yang terkena tsunami di Thailand adalah daerah Pariwisata sektor swasta yang turut serta dalam membangun wilayah tersebut sangat besar. Provinsi Aceh di Indonesia adalah wilayah pertambangan dengan jumlah penduduk yang lebih besar dari wilayah-wilayah yang terkena dampak tsunami di Thailand.

Pada penelitian ini, peneliti mengalami kendala untuk mendapatkan data perekonomian dari Srilanka, sehingga perbandingan pemulihan perekomian di negara ini belum dapat diberikan pada penitian saat ini.

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Lampiran A. Hasil Uji Beda Berpasangan untuk GRDP Indonesia

Tabel A1. Hasil uji beda berpasangan untuk GRDP

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-42632129.7218	-13.1756	***	-71504753.0000	-12.6344	***
2	ACEH-SUMATERA BARAT	16150298.3764	15.8060	***	-241649.4286	-0.1133	
3	ACEH-RIAU	-43128789.1945	-12.6604	***	-92640874.2857	-17.3147	***
4	ACEH-JAMBI	32823704.0127	29.6372	***	19294690.4286	14.0305	***
5	ACEH-SUMATERA SELATAN	-7902652.5373	-6.1229	***	-33431645.7143	-10.1559	***
6	ACEH-BENGKULU	38473710.1645	33.5876	***	27276122.5714	29.3512	***
7	ACEH-LAMPUNG	17867246.2291	15.6941	***	66647.4286	0.0327	
8	ACEH-DKI JAKARTA	-208717339.9018	-31.9079	***	-320122196.1429	-18.2473	***
9	ACEH-JAWA BARAT	-214882750.9745	-30.0796	***	-333126191.7143	-17.6523	***
10	ACEH-JAWA TENGAH	-106357901.3382	-15.6373	***	-134206654.2857	-16.9336	***
11	ACEH- D I YOGYAKARTA	26450511.3791	31.5979	***	15557386.2857	11.8550	***
12	ACEH-JAWA TIMUR	-188940682.3745	-29.8942	***	-272623709.2857	-17.8724	***
13	ACEH-BALI	19420146.0145	15.0005	***	8969253.1429	4.8803	***
14	ACEH-NUSA TENGGARA BARAT	31529349.4491	22.7834	***	17280334.8571	13.1108	***
15	ACEH-NUSA TENGGARA TIMUR	34635939.8673	31.2364	***	23289311.2857	23.0249	***
16	ACEH-KALIMANTAN BARAT	19806157.5418	16.6183	***	7200674.2857	4.3288	**
17	ACEH-KALIMANTAN TENGAH	30151608.5736	30.5476	***	17920337.2857	13.3610	***
18	ACEH-KALIMANTAN SELATAN	22132716.5173	19.7433	***	7112645.4286	3.9987	***
19	ACEH-KALIMANTAN TIMUR	-39621285.4109	-14.3452	***	-68644652.5714	-20.2198	***
20	ACEH-SULAWESI UTARA	31032168.5391	27.2599	***	16244364.4286	9.8186	***
21	ACEH-SULAWESI TENGAH	35576369.0309	25.8008	***	19545891.5714	12.8116	***
22	ACEH-SELAWESI SELATAN	8087452.3464	6.7741	***	-14244802.7143	-4.3191	***
23	ACEH-SULAWESI TENGGARA	38363769.1200	29.2416	***	24604873.5714	21.1554	***
24	ACEH-MALUKU	35898811.2045	48.5772	***	28232775.5714	32.0495	***
25	ACEH-PAPUA	17759314.0536	9.2993	***	6593463.4286	3.5887	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A2. Hasil uji beda berpasangan untuk partisipasi sekolah tingkat SD

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-1274371.9091	-57.0362	***	-1264521.8571	-96.9305	***
2	ACEH-SUMATERA BARAT	-106360.3636	-7.2789	***	-115170.5714	-14.8647	***
3	ACEH-RIAU	-95169.9091	-7.9552	***	-280969.1429	-11.5421	***
4	ACEH-JAMBI	202098.6364	28.7961	***	154480.1429	16.9407	***
5	ACEH-SUMATERA SELATAN	-532566.4545	-46.5945	***	-520846.4286	-41.0979	***
6	ACEH-BENGKULU	339389.4545	50.6719	***	310787.1429	147.3378	***
7	ACEH-LAMPUNG	-449807.7273	-54.8445	***	-497380.5714	-117.7792	***
8	ACEH-DKI JAKARTA	-312474.1818	-11.2020	***	-279910.1429	-58.8107	***
9	ACEH-JAWA BARAT	-4675266.3636	-83.8171	***	-5134163.5714	-67.9557	***
10	ACEH-JAWA TENGAH	-3187609.7273	-55.1645	***	-2875662.0000	-296.0406	***
11	ACEH- D I YOGYAKARTA	246608.5455	16.1428	***	253336.2857	79.0967	***
12	ACEH-JAWA TIMUR	-2848229.6364	-41.1037	***	-2736115.0000	-475.7014	***
13	ACEH-BALI	219841.2727	21.8961	***	146757.4286	18.7172	***
14	ACEH-NUSA TENGGARA BARAT	10638.8182	2.1679	***	-21750.1429	-12.2439	***
15	ACEH-NUSA TENGGARA TIMUR	-37541.1818	-6.3919	***	-182560.0000	-7.8355	***
16	ACEH-KALIMANTAN BARAT	-35234.0909	-6.4195	***	-88883.2857	-15.1602	***
17	ACEH-KALIMANTAN TENGAH	305113.0909	37.8013	***	247255.0000	33.8679	***
18	ACEH-KALIMANTAN SELATAN	190092.9091	26.9128	***	147040.5714	27.5745	***
19	ACEH-KALIMANTAN TIMUR	214141.0909	20.4710	***	138102.7143	15.8125	***
20	ACEH-SULAWESI UTARA	214462.5455	28.0825	***	136387.2857	14.2073	***
21	ACEH-SULAWESI TENGAH	255974.2727	45.2715	***	212621.0000	20.8814	***
22	ACEH-SELAWESI SELATAN	-515843.0909	-40.8994	***	-635988.1429	-51.3523	***
23	ACEH-SULAWESI TENGGARA	277676.8182	43.2949	***	212882.5714	38.5848	***
24	ACEH-MALUKU	201481.1818	26.8451	***	146357.4286	12.8123	***
25	ACEH-PAPUA	254503.6364	32.5882	***	151171.5714	9.8699	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A3. Hasil uji beda berpasangan untuk partisipasi sekolah tingkat SMP

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-407585.3636	-75.2607	***	-429924.2857	-56.0982	***
2	ACEH-SUMATERA BARAT	-34640.0000	-17.0277	***	2842.0000	0.4941	
3	ACEH-RIAU	-1657.3636	-0.6561		-24133.2857	-3.2491	***
4	ACEH-JAMBI	62693.4545	19.1489	***	98907.4286	19.0081	***
5	ACEH-SUMATERA SELATAN	-126313.1818	-24.0746	***	-131852.2857	-26.8378	***
6	ACEH-BENGKULU	82021.7273	20.5624	***	127577.4286	39.5063	***
7	ACEH-LAMPUNG	-107622.0000	-16.6702	***	-89747.4286	-14.9120	***
8	ACEH-DKI JAKARTA	-285075.2727	-20.5710	***	-171657.2857	-39.9746	***
9	ACEH-JAWA BARAT	-1056223.7273	-19.8810	***	-1475026.8571	-20.8412	***
10	ACEH-JAWA TENGAH	-959681.2727	-29.4934	***	-1022541.4286	-56.9312	***
11	ACEH- D I YOGYAKARTA	-3388.0000	-0.5304		73163.7143	16.6003	***
12	ACEH-JAWA TIMUR	-929196.5455	-30.5938	***	-947932.8571	-51.4977	***
13	ACEH-BALI	13252.7273	2.5260	***	50058.7143	12.9960	***
14	ACEH-NUSA TENGGARA BARAT	35581.0000	13.0053	***	49091.7143	22.8281	***
15	ACEH-NUSA TENGGARA TIMUR	18058.3636	8.5273	***	7011.0000	1.3446	
16	ACEH-KALIMANTAN BARAT	19360.9091	10.7240	***	134571.8571	9.2381	***
17	ACEH-KALIMANTAN TENGAH	87727.0000	18.9923	***	28935.1429	35.7013	***
18	ACEH-KALIMANTAN SELATAN	68756.2727	17.3300	***	105670.2857	44.7807	***
19	ACEH-KALIMANTAN TIMUR	45126.0000	13.7766	***	71567.5714	33.5729	***
20	ACEH-SULAWESI UTARA	38402.1818	8.6781	***	66476.8571	14.3881	***
21	ACEH-SULAWESI TENGAH	77090.2727	16.8251	***	116992.2857	28.6534	***
22	ACEH-SELAWESI SELATAN	-132689.0909	-40.6456	***	-150920.1429	-18.3538	***
23	ACEH-SULAWESI TENGGARA	70111.2727	28.2555	***	101180.5714	21.6137	***
24	ACEH-MALUKU	49946.8182	11.4985	***	88046.7143	19.5303	***
25	ACEH-PAPUA	65905.7273	15.6686	***	88317.1429	17.1751	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A4. Hasil uji beda berpasangan untuk partisipasi sekolah tingkat SMA

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-298063.9091	-32.0230	***	-389645.1429	-50.6939	***
2	ACEH-SUMATERA BARAT	-49016.9091	-30.1725	***	-25115.5714	-3.9716	***
3	ACEH-RIAU	-3800.2727	-1.4728		-17934.8571	-19.6712	***
4	ACEH-JAMBI	35635.4545	32.3796	***	73862.8571	9.2918	***
5	ACEH-SUMATERA SELATAN	-77412.2727	-25.5546	***	-98732.2857	-105.9971	***
6	ACEH-BENGKULU	45669.4545	31.0632	***	96218.8571	9.8348	***
7	ACEH-LAMPUNG	-43182.0000	-12.0709	***	-35239.0000	-6.5405	***
8	ACEH-DKI JAKARTA	-335688.1818	-61.5653	***	-267209.1429	-52.2135	***
9	ACEH-JAWA BARAT	-578898.9091	-22.4405	***	-1004347.5714	-16.6795	***
10	ACEH-JAWA TENGAH	-568739.6364	-32.3356	***	-711600.5714	-49.9087	***
11	ACEH- D I YOGYAKARTA	-43236.2727	-24.9996	***	28163.4286	2.4700	**
12	ACEH-JAWA TIMUR	-609744.0000	-32.3730	***	-799720.5714	-33.6235	***
13	ACEH-BALI	-13514.8182	-4.4071	***	34758.7143	3.9874	***
14	ACEH-NUSA TENGGARA BARAT	20673.0000	13.3965	***	41710.8571	7.0785	***
15	ACEH-NUSA TENGGARA TIMUR	19026.4545	8.6612	***	25262.5714	8.0675	***
16	ACEH-KALIMANTAN BARAT	16493.9091	10.5100	***	46102.2857	8.2754	***
17	ACEH-KALIMANTAN TENGAH	50762.7273	20.2360	***	103526.4286	11.7581	***
18	ACEH-KALIMANTAN SELATAN	32865.1818	19.0442	***	84226.5714	8.6096	***
19	ACEH-KALIMANTAN TIMUR	17945.0000	15.0780	***	47261.0000	6.9873	***
20	ACEH-SULAWESI UTARA	9221.4545	3.8637	***	51884.5714	7.7862	***
21	ACEH-SULAWESI TENGAH	46362.0909	26.8380	***	88621.5714	11.2201	***
22	ACEH-SELAWESI SELATAN	-94007.6364	-32.9900	***	-106745.1429	-22.6625	***
23	ACEH-SULAWESI TENGGARA	42313.8182	31.2885	***	77888.2857	8.9599	***
24	ACEH-MALUKU	23793.0909	11.3877	***	56461.8571	8.4019	***
25	ACEH-PAPUA	37118.4545	25.8556	***	70908.1429	8.5908	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A5. Hasil uji beda berpasangan untuk partisipasi sekolah tingkat universitas

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-98310.8182	-17.9314	***	-132869.7143	-15.1955	***
2	ACEH-SUMATERA BARAT	-24389.9091	-19.5270	***	-2271.0000	-0.7570	
3	ACEH-RIAU	15845.4545	10.1492	***	39592.7143	6.8441	***
4	ACEH-JAMBI	30881.3636	12.5302	***	66068.5714	9.3451	***
5	ACEH-SUMATERA SELATAN	-7343.0000	-4.8363	***	2267.8571	0.4567	
6	ACEH-BENGKULU	30845.1818	14.8596	***	70325.7143	9.3054	***
7	ACEH-LAMPUNG	7262.6364	4.5956	***	28711.8571	4.0562	***
8	ACEH-DKI JAKARTA	-706766.8182	-10.3153	***	-786893.1429	-6.3482	***
9	ACEH-JAWA BARAT	-214374.9091	-18.5956	***	-362206.4286	-17.4097	***
10	ACEH-JAWA TENGAH	-160479.7273	-19.5265	***	-196265.4286	-20.5448	***
11	ACEH- D I YOGYAKARTA	-138729.5455	-15.2134	***	-140790.7143	-15.6720	***
12	ACEH-JAWA TIMUR	-338552.5455	-31.1906	***	-366323.7143	-13.1668	***
13	ACEH-BALI	41834.5091	15.8507	***	92117.4714	8.8517	***
14	ACEH-NUSA TENGGARA BARAT	17526.8182	8.1501	***	47899.0000	7.5899	***
15	ACEH-NUSA TENGGARA TIMUR	22860.3636	15.9471	***	57745.4286	7.9474	***
16	ACEH-KALIMANTAN BARAT	20244.9091	11.6598	***	58927.4286	8.8112	***
17	ACEH-KALIMANTAN TENGAH	29062.5455	11.5509	***	74304.7143	7.9948	***
18	ACEH-KALIMANTAN SELATAN	17085.5455	10.9614	***	56694.4286	8.0575	***
19	ACEH-KALIMANTAN TIMUR	17461.7273	10.5951	***	37001.5714	7.0135	***
20	ACEH-SULAWESI UTARA	11027.5455	7.9588	***	38267.1429	6.0427	***
21	ACEH-SULAWESI TENGAH	25609.6364	15.5811	***	61337.0000	8.9811	***
22	ACEH-SELAWESI SELATAN	-63451.1818	-14.0949	***	-81950.4286	-14.6525	***
23	ACEH-SULAWESI TENGGARA	27170.4545	18.3262	***	65105.2857	9.3393	***
24	ACEH-MALUKU	24312.0000	10.0476	***	55222.0000	7.9678	***
25	ACEH-PAPUA	26047.4545	23.2708	***	50536.0000	6.9399	***

(, **, * untuk level signifikansi 1%, 5% dan 10%)***

Tabel A6. Hasil uji beda berpasangan untuk tingkat melek huruf

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-3.7256	-7.0519	***	-1.7300	-3.0045	**
2	ACEH-SUMATERA BARAT	-1.8744	-4.6851	***	-1.2700	-2.2691	*
3	ACEH-RIAU	-3.0700	-6.1361	***	-99.0043	-166.1675	***
4	ACEH-JAMBI	-1.6922	-3.7547	***	-0.1629	-0.2965	
5	ACEH-SUMATERA SELATAN	-21.7533	-1.5893		-97.1343	-178.5294	***
6	ACEH-BENGKULU	-1.0389	-1.6636		0.4943	0.9724	
7	ACEH-LAMPUNG	0.4467	0.8038		0.4943	0.9724	
8	ACEH-DKI JAKARTA	-5.6411	-7.8734	***	1.0914	2.0855	*
9	ACEH-JAWA BARAT	-21.0411	-1.5090		-3.4286	-6.1026	***
10	ACEH-JAWA TENGAH	6.5967	13.1241	***	-96.4486	-179.1352	***
11	ACEH- D I YOGYAKARTA	8.3344	13.5688	***	5.5486	11.1331	***
12	ACEH-JAWA TIMUR	10.5467	11.8889	***	5.7643	13.0979	***
13	ACEH-BALI	9.1844	17.4736	***	7.1286	13.7180	***
14	ACEH-NUSA TENGGARA BARAT	16.8556	14.7403	***	7.4914	12.7712	***
15	ACEH-NUSA TENGGARA TIMUR	8.7933	6.5052	***	13.5157	17.3424	***
16	ACEH-KALIMANTAN BARAT	7.7789	10.1517	***	7.2900	16.6472	***
17	ACEH-KALIMANTAN TENGAH	-2.9778	-6.1244	***	5.3614	9.6716	***
18	ACEH-KALIMANTAN SELATAN	-0.5256	-1.0604		-1.9243	-2.7866	**
19	ACEH-KALIMANTAN TIMUR	-1.0678	-2.8581	**	-1.1571	-2.4478	**
20	ACEH-SULAWESI UTARA	-26.8778	-1.9659	*	-99.2671	-180.1179	***
21	ACEH-SULAWESI TENGAH	-0.5856	-1.1319		-0.0271	-0.0553	
22	ACEH-SELAWESI SELATAN	8.8889	10.5413	***	-67.5257	-5.5374	***
23	ACEH-SULAWESI TENGGARA	3.5744	6.6013	***	3.7686	6.6479	***
24	ACEH-MALUKU	-15.5938	-1.3441		-97.4371	-192.9584	***
25	ACEH-PAPUA	27.8333	3.2713	**	-54.8429	-4.4675	***

(, **, * untuk level signifikansi 1%, 5% dan 10%)***

Tabel A7. Hasil uji beda berpasangan untuk sektor pertanian

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-15252405.5864	-16.3060	***	2133619.6479	-21.1162	***
2	ACEH-SUMATERA BARAT	2575968.0755	8.3065	***	292276.4128	-0.1323	
3	ACEH-RIAU	739735.5055	0.5762		1054947.6084	-21.8256	
4	ACEH-JAMBI	5449413.3218	14.2552	***	168266.7438	57.5466	***
5	ACEH-SUMATERA SELATAN	-1408256.4955	-4.5437	***	837829.8630	-16.9821	***
6	ACEH-BENGKULU	6766763.9273	16.0431	***	303614.6371	47.7211	***
7	ACEH-LAMPUNG	-1295841.5964	-2.3693		562645.9485	-27.1784	***
8	ACEH-DKI JAKARTA	8429934.8582	19.5068	***	556179.8083	38.4321	***
9	ACEH-JAWA BARAT	-28770154.0791	-42.6547	***	3672642.2501	-25.8626	***
10	ACEH-JAWA TENGAH	-23162268.4518	-25.8569	***	1546831.0645	-41.9054	***
11	ACEH- D I YOGYAKARTA	5659807.5227	16.5330	***	443055.9813	29.4045	***
12	ACEH-JAWA TIMUR	-33460026.1627	-140.7997	***	2326595.8577	-45.7912	***
13	ACEH-BALI	3668494.3745	20.6298	***	226527.7926	35.7944	***
14	ACEH-NUSA TENGGARA BARAT	4507240.6573	18.5021	***	283354.4906	38.1300	***
15	ACEH-NUSA TENGGARA TIMUR	4800796.9985	15.1368	***	337157.5432	30.7487	***
16	ACEH-KALIMANTAN BARAT	2757826.5427	13.3638	***	214967.9013	17.5960	***
17	ACEH-KALIMANTAN TENGAH	3291329.0291	18.2685	***	362978.1773	19.8114	***
18	ACEH-KALIMANTAN SELATAN	3767154.5045	10.9004	***	268285.1330	17.3374	***
19	ACEH-KALIMANTAN TIMUR	2086522.6536	7.5503	***	128441.1292	30.7201	***
20	ACEH-SULAWESI UTARA	5381658.6173	17.8971	***	216064.6615	53.8277	***
21	ACEH-SULAWESI TENGAH	5138177.7345	10.3398	***	269986.9752	20.0406	***
22	ACEH-SELAWESI SELATAN	-4497044.1000	-51.9447	***	918739.6104	-18.7404	***
23	ACEH-SULAWESI TENGGARA	6690327.4836	14.4056	***	352100.0792	37.4779	***
24	ACEH-MALUKU	6243145.5845	19.2672	***	355478.0663	46.2380	***
25	ACEH-PAPUA	4232221.1255	19.0796	***	168427.6805	49.0962	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A8. Hasil uji beda berpasangan untuk sektor pertambangan

		Sebelum Tsunami			SesudahTsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	11346722.9347	15.5072	***	4343641.0000	3.5630	*
2	ACEH-SUMATERA BARAT	11504414.7345	13.4320	***	4529888.6900	3.7539	***
3	ACEH-RIAU	-33450008.9882	-32.9789	***	-42824097.6957	-24.2765	***
4	ACEH-JAMBI	12109586.9173	13.8600	***	3737245.9786	2.8886	**
5	ACEH-SUMATERA SELATAN	2227008.1536	1.8710	*	-9669960.9071	-7.2420	***
6	ACEH-BENGKULU	12885917.3755	15.8163	***	5358836.2943	4.5283	***
7	ACEH-LAMPUNG	12433607.2891	15.4602	***	4824864.4957	4.2277	***
8	ACEH-DKI JAKARTA	12642021.7127	14.8800	***	4672737.6157	3.9787	***
9	ACEH-JAWA BARAT	343404.4273	0.2723		-1547252.0614	-1.2541	
10	ACEH-JAWA TENGAH	11248997.6188	13.0151	***	3763858.4314	3.0002	**
11	ACEH- D I YOGYAKARTA	12861973.5691	15.8142	***	5484446.1000	4.6905	***
12	ACEH-JAWA TIMUR	9113465.8663	12.4193	***	-991796.3457	-0.6206	
13	ACEH-BALI	12896030.0382	15.8078	***	5462052.9443	4.6493	***
14	ACEH-NUSA TENGGARA BARAT	11429491.7227	11.6531	***	1233968.1814	0.9518	
15	ACEH-NUSA TENGGARA TIMUR	12930166.9221	15.8815	***	5469687.4800	4.6699	***
16	ACEH-KALIMANTAN BARAT	12755933.8455	15.4111	***	5185585.3943	4.2952	***
17	ACEH-KALIMANTAN TENGAH	12607290.4136	14.6180	***	4127767.8814	3.1719	**
18	ACEH-KALIMANTAN SELATAN	9868130.3064	9.2935	***	-444344.1286	-0.3047	
19	ACEH-KALIMANTAN TIMUR	-14613613.0509	-8.9944	***	-35739057.7643	-12.2199	***
20	ACEH-SULAWESI UTARA	12342476.4200	14.3200	***	4766460.6086	3.9315	***
21	ACEH-SULAWESI TENGAH	12853183.0582	15.7316	***	5039423.2771	3.9922	***
22	ACEH-SELAWESI SELATAN	11107968.4045	12.4638	***	1557989.8686	1.2623	
23	ACEH-SULAWESI TENGGARA	12851132.9891	15.9019	***	5037184.8586	4.1530	***
24	ACEH-MALUKU	12702208.7464	16.0745	***	5472862.8329	4.6818	***
25	ACEH-PAPUA	-2252152.5045	-1.2023		-5574624.2629	-5.4614	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A9. Hasil uji beda berpasangan untuk sektor manufaktur

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-9250381.1218	-18.1751	***	-19870716.7286	-19.4056	***
2	ACEH-SUMATERA BARAT	7292428.5182	16.0224	***	-106044.6143	-0.2227	
3	ACEH-RIAU	-4324376.4291	-2.8134	**	-24576066.8000	-15.2032	***
4	ACEH-JAMBI	9606533.8409	17.5993	***	2270056.9286	5.8388	***
5	ACEH-SUMATERA SELATAN	1218586.2218	2.7804	**	-7974813.8571	-11.2610	***
6	ACEH-BENGKULU	11364637.6918	17.6691	***	4006663.0857	12.1592	***
7	ACEH-LAMPUNG	7768641.7045	14.1310	***	-308046.6857	-0.5907	
8	ACEH-DKI JAKARTA	-38803697.4164	-21.7512	***	-52899565.4571	-30.2622	***
9	ACEH-JAWA BARAT	-86079145.1018	-14.3564	***	-162215392.0571	-20.3265	***
10	ACEH-JAWA TENGAH	-35628256.3664	-18.4472	***	-50663623.0857	-17.0705	***
11	ACEH- D I YOGYAKARTA	9037035.2964	15.7021	***	1687121.8571	4.5323	***
12	ACEH-JAWA TIMUR	-54008209.7000	-23.4509	***	-76321074.3571	-23.9793	***
13	ACEH-BALI	9478894.6336	16.7813	***	1759243.0714	3.8263	***
14	ACEH-NUSA TENGGARA BARAT	11015479.4709	17.2335	***	3488122.5000	9.7962	***
15	ACEH-NUSA TENGGARA TIMUR	11392312.2075	18.0560	***	4144635.1143	13.0770	***
16	ACEH-KALIMANTAN BARAT	6539257.1709	12.1094	***	-590149.5286	-1.4868	
17	ACEH-KALIMANTAN TENGAH	10080602.2373	18.6448	***	2971063.7714	8.4613	***
18	ACEH-KALIMANTAN SELATAN	7385149.1073	19.2986	***	1199599.3429	3.3129	**
19	ACEH-KALIMANTAN TIMUR	-18397937.2182	-9.3655	***	-27611401.2714	-64.9254	***
20	ACEH-SULAWESI UTARA	10403912.4082	16.6395	***	2874425.9714	7.3315	***
21	ACEH-SULAWESI TENGAH	10904706.7036	16.8276	***	3349389.5000	9.1804	***
22	ACEH-SELAWESI SELATAN	7041531.4873	11.4497	***	-2207281.4571	-3.4585	**
23	ACEH-SULAWESI TENGGARA	11097955.8227	16.8117	***	3456124.9857	9.2296	***
24	ACEH-MALUKU	10217098.7064	24.6461	***	3772744.5286	11.6018	***
25	ACEH-PAPUA	10609288.5236	17.5443	***	2018992.4571	2.3119	***

(, **, * untuk level signifikansi 1%, 5% dan 10%)***

Tabel A10. Hasil uji beda berpasangan untuk sektor listrik, gas dan air bersih

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-859218.0218	-8.2005	***	-706098.1686	-32.5135	***
2	ACEH-SUMATERA BARAT	-306837.4363	-6.8963	***	-311796.9414	-49.8828	***
3	ACEH-RIAU	-192325.9876	-12.2059	***	-286429.4814	-14.3334	***
4	ACEH-JAMBI	-9555.7785	-2.5249	**	-29755.4800	-12.2820	***
5	ACEH-SUMATERA SELATAN	-265921.9105	-11.4790	***	-242693.3143	-35.3289	***
6	ACEH-BENGKULU	32333.3875	7.5080	***	58816.4343	7.6487	***
7	ACEH-LAMPUNG	-73026.9320	-5.9787	***	-32515.7457	-9.4631	***
8	ACEH-DKI JAKARTA	-3429260.9983	-7.4576	***	-2236209.6600	-24.8225	***
9	ACEH-JAWA BARAT	-6588236.4116	-24.3573	***	-9129969.4943	-20.7766	***
10	ACEH-JAWA TENGAH	-1200818.6850	-11.0625	***	-1330902.2214	-22.4495	***
11	ACEH- D I YOGYAKARTA	-49649.8203	-6.4948	***	-81200.8557	-24.9711	***
12	ACEH-JAWA TIMUR	-3889218.0206	-12.0165	***	-4383654.2829	-44.6691	***
13	ACEH-BALI	-217098.2581	-14.1003	***	-294534.0686	-25.5917	***
14	ACEH-NUSA TENGGARA BARAT	24923.6905	4.7721	***	32855.6200	5.5717	***
15	ACEH-NUSA TENGGARA TIMUR	7788.0679	4.1709	***	46997.7286	6.0337	***
16	ACEH-KALIMANTAN BARAT	-86934.3573	-7.5650	***	-25725.7357	-4.3166	***
17	ACEH-KALIMANTAN TENGAH	25695.3155	2.9661	***	17009.8229	2.3553	*
18	ACEH-KALIMANTAN SELATAN	-153657.3616	-6.2230	***	-46401.9429	-10.6636	***
19	ACEH-KALIMANTAN TIMUR	-156525.2513	-23.6052	***	-233072.3714	-31.0355	***
20	ACEH-SULAWESI UTARA	-19421.0661	-2.9115	***	-43765.5486	-23.1064	***
21	ACEH-SULAWESI TENGAH	13214.2274	1.4667		-17511.8100	-3.9367	***
22	ACEH-SELAWESI SELATAN	-321777.1109	-13.4358	***	-374772.9500	-14.9989	***
23	ACEH-SULAWESI TENGGARA	35410.8068	5.6617	***	20284.5529	4.2601	***
24	ACEH-MALUKU	25560.8192	4.3894	***	61163.1229	6.4093	***
25	ACEH-PAPUA	11985.5816	2.9409	**	18220.9171	2.9183	*

(, **, * untuk level signifikansi 1%, 5% dan 10%)***

Tabel A11. Hasil uji beda berpasangan untuk sektor bangunan dan konstruksi

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-2334870.3122	-17.6588	***	-5018946.6800	-16.7301	***
2	ACEH-SUMATERA BARAT	335417.1100	7.7094	***	281983.2357	3.3783	**
3	ACEH-RIAU	-393316.1564	-2.9856	**	-2372194.2186	-7.6386	***
4	ACEH-JAMBI	1309797.2491	22.8248	***	1358024.1100	12.4342	***
5	ACEH-SUMATERA SELATAN	-1762009.5627	-13.6496	***	-3083273.8400	-13.6181	***
6	ACEH-BENGKULU	1526879.1645	20.9361	***	1846085.9157	13.1753	***
7	ACEH-LAMPUNG	-176722.1391	-1.2779		373936.9014	3.7654	***
8	ACEH-DKI JAKARTA	-29605775.3336	-13.0515	***	-34217508.9700	-17.6897	***
9	ACEH-JAWA BARAT	-9693759.2491	-6.8406	***	-10011568.1200	-12.7545	***
10	ACEH-JAWA TENGAH	-5169351.9594	-17.9624	***	-7663495.3186	-19.6879	***
11	ACEH- D I YOGYAKARTA	210702.3355	2.6438	*	256495.3029	3.9104	***
12	ACEH-JAWA TIMUR	-10798960.4200	-9.4360	***	-8035554.1029	-26.4423	***
13	ACEH-BALI	697799.1500	9.7622	***	1051795.3843	10.0543	***
14	ACEH-NUSA TENGGARA BARAT	860880.0509	10.3364	***	781767.7071	8.6878	***
15	ACEH-NUSA TENGGARA TIMUR	1061090.8985	14.2092	***	1335658.8871	9.8914	***
16	ACEH-KALIMANTAN BARAT	218522.9500	2.1271	*	-183501.1257	-2.2798	*
17	ACEH-KALIMANTAN TENGAH	1041014.0109	17.4792	***	1184369.9786	12.3188	***
18	ACEH-KALIMANTAN SELATAN	652661.6818	10.7658	***	543560.9600	6.0576	***
19	ACEH-KALIMANTAN TIMUR	-487291.8809	-4.5023	***	-1614122.4114	-9.7484	***
20	ACEH-SULAWESI UTARA	236453.2709	1.9067	*	-677493.1057	-7.8610	***
21	ACEH-SULAWESI TENGAH	1169594.8182	13.1410	***	1049445.1600	11.5388	***
22	ACEH-SELAWESI SELATAN	-28793.0627	-0.4364		-471410.5200	-3.1435	**
23	ACEH-SULAWESI TENGGARA	1207177.9545	16.0424	***	1211514.4543	12.6416	***
24	ACEH-MALUKU	1361127.1145	29.0899	***	1966796.7214	13.7371	***
25	ACEH-PAPUA	302240.2773	3.1565	***	-45964.8129	-0.2955	

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A12. Hasil uji beda berpasangan untuk sektor perdagangan, hotel dan restoran

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-12519319.0218	-12.5573	***	-13561898.2143	-17.3660	***
2	ACEH-SUMATERA BARAT	-1485337.8773	-3.4760	***	-332232.7429	-5.1310	***
3	ACEH-RIAU	-3873591.8155	-14.9466	***	-9895121.3714	-12.5949	***
4	ACEH-JAMBI	1359595.6027	3.4094	***	3369030.7429	38.6790	***
5	ACEH-SUMATERA SELATAN	-5240985.0782	-6.3493	***	-3892075.1429	-14.4696	***
6	ACEH-BENGKULU	2387035.8464	7.5867	***	4527184.4000	25.4431	***
7	ACEH-LAMPUNG	-794164.1655	-2.0571	*	551142.2857	13.7068	***
8	ACEH-DKI JAKARTA	-52292487.9827	-22.4135	***	-70951968.6857	-19.7096	***
9	ACEH-JAWA BARAT	-52292487.9827	-22.4135	***	-67842687.2000	-14.5416	***
10	ACEH-JAWA TENGAH	-45506583.1391	-28.9676	***	-29951304.1000	-19.9733	***
11	ACEH- D I YOGYAKARTA	-29474190.0536	-14.2419	***	2051792.9714	23.8840	***
12	ACEH-JAWA TIMUR	358419.2136	0.9761		-86845601.1714	-16.3638	***
13	ACEH-BALI	-49312433.4291	-30.9949	***	-2092543.8429	-8.6106	***
14	ACEH-NUSA TENGGARA BARAT	-4386223.5509	-5.0722	***	3457414.1857	35.5531	***
15	ACEH-NUSA TENGGARA TIMUR	1466221.8627	3.8593	***	4120590.2429	27.5437	***
16	ACEH-KALIMANTAN BARAT	2007928.1176	6.0162	***	22181.6714	0.2246	
17	ACEH-KALIMANTAN TENGAH	-1754609.1918	-3.4658	***	3023900.4857	42.0302	***
18	ACEH-KALIMANTAN SELATAN	802771.6691	1.8227	***	1820807.6143	54.9033	***
19	ACEH-KALIMANTAN TIMUR	-191872.6436	-0.4220	***	-2563283.5714	-8.6296	***
20	ACEH-SULAWESI UTARA	-3366858.5382	-5.1323	***	3159835.7143	102.4109	***
21	ACEH-SULAWESI TENGAH	1726564.8891	5.7445	***	4076580.3857	35.4891	***
22	ACEH-SELAWESI SELATAN	2306448.6300	7.6008	***	-1714255.5429	-4.4656	***
23	ACEH-SULAWESI TENGGARA	-2302203.4236	-3.9869	***	4370464.0429	41.9680	***
24	ACEH-MALUKU	2568988.4300	8.9015	***	4358442.5286	30.0661	***
25	ACEH-PAPUA	1688451.5855	3.5396	***	3973728.3000	43.4390	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A13. Hasil uji beda berpasangan untuk sektor pengangkutan dan komunikasi

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-4582865.5959	-16.5200	***	-7748800.6729	-13.0243	***
2	ACEH-SUMATERA BARAT	-921858.8464	-6.1484	***	-2772975.8843	-12.1161	***
3	ACEH-RIAU	217011.3164	0.8622		-1989503.0500	-10.2742	***
4	ACEH-JAMBI	1337629.9700	6.2604	***	981898.2843	14.9697	***
5	ACEH-SUMATERA SELATAN	127043.4055	0.8948		-1133207.1829	-5.3920	***
6	ACEH-BENGKULU	1614605.7073	8.1489	***	1553058.5086	18.6854	***
7	ACEH-LAMPUNG	583772.7100	3.5964	***	-127514.7900	-1.3592	
8	ACEH-DKI JAKARTA	-17509718.3655	-17.0690	***	-34492605.7871	-8.5995	***
9	ACEH-JAWA BARAT	-11249873.9445	-19.3777	***	-17448049.2629	-13.1647	***
10	ACEH-JAWA TENGAH	-4082189.6465	-28.0627	***	-6488528.4329	-17.0273	***
11	ACEH- D I YOGYAKARTA	510501.0900	3.5355	***	166983.0314	7.4341	***
12	ACEH-JAWA TIMUR	-12586227.5300	-19.3173	***	-18457180.6000	-10.5164	***
13	ACEH-BALI	-624421.9582	-8.4726	***	-618076.0857	-10.4803	***
14	ACEH-NUSA TENGGARA BARAT	1237089.4491	6.4484	***	835634.8543	17.9921	***
15	ACEH-NUSA TENGGARA TIMUR	1543526.9515	8.0953	***	1357131.1986	19.4607	***
16	ACEH-KALIMANTAN BARAT	146873.5655	2.3420	***	-108342.9114	-1.0394	
17	ACEH-KALIMANTAN TENGAH	891920.6709	6.4491	***	845798.4300	18.7598	***
18	ACEH-KALIMANTAN SELATAN	320925.2327	2.3732	**	-213756.6857	-13.5732	***
19	ACEH-KALIMANTAN TIMUR	-3920874.7427	-6.8227	***	-3335961.2971	-12.6303	***
20	ACEH-SULAWESI UTARA	655001.3045	3.5968	***	-59988.9614	-0.7556	***
21	ACEH-SULAWESI TENGAH	1705853.5236	6.6982	***	1074258.1457	37.6652	***
22	ACEH-SELAWESI SELATAN	20017.3518	0.1116		-1715375.6771	-7.0657	
23	ACEH-SULAWESI TENGGARA	1944015.4218	7.4637	***	1350648.6571	29.7715	***
24	ACEH-MALUKU	1881276.9345	7.7606	***	1568307.8529	20.6353	***
25	ACEH-PAPUA	1534280.2018	6.4593	***	310183.3214	3.8056	***

(, **, * untuk level signifikansi 1%, 5% dan 10%***

Tabel A14. Hasil uji beda berpasangan untuk sektor keuangan, real estate dan jasa perusahaan

		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-5285953.2427	-14.5757	***	-6923753.6743	-12.0568	***
2	ACEH-SUMATERA BARAT	-1044419.7509	-18.6013	***	-1244014.1171	-20.8560	***
3	ACEH-RIAU	-2076918.5373	-8.4437	***	-2290036.7443	-13.3017	***
4	ACEH-JAMBI	-10768.4927	-0.1989		-207882.3157	-3.3306	**
5	ACEH-SUMATERA SELATAN	-1906424.0827	-15.0019	***	-2183046.2343	-15.6500	***
6	ACEH-BENGKULU	166119.1600	2.4381	***	193274.8786	20.9941	***
7	ACEH-LAMPUNG	-893333.3155	-10.1662	**	-2295613.0757	-7.6324	***
8	ACEH-DKI JAKARTA	-64965104.7009	-17.9998	***	-102508284.4543	-29.4353	***
9	ACEH-JAWA BARAT	-9709507.8036	-10.5946	***	-11380734.3900	-14.0249	***
10	ACEH-JAWA TENGAH	-6257637.4732	-11.2453	***	-5688137.8757	-18.4695	***
11	ACEH- D I YOGYAKARTA	-1362698.1373	-10.7507	***	-1276850.8157	-22.7816	***
12	ACEH-JAWA TIMUR	-13287411.1236	-16.6207	***	-15778141.9014	-15.9736	***
13	ACEH-BALI	-1256234.6591	-13.3964	***	-1302057.3786	-26.3282	***
14	ACEH-NUSA TENGGARA BARAT	79657.2845	1.0145		-342120.4314	-10.8546	***
15	ACEH-NUSA TENGGARA TIMUR	84955.2433	1.3179		147766.0457	24.4540	***
16	ACEH-KALIMANTAN BARAT	-1103982.9555	-8.1953	***	-931697.1671	-15.1834	***
17	ACEH-KALIMANTAN TENGAH	41827.8273	0.5862		-343711.1457	-5.2477	***
18	ACEH-KALIMANTAN SELATAN	-406509.5436	-7.3851	***	-532066.4614	-12.8342	***
19	ACEH-KALIMANTAN TIMUR	-1869702.6209	-12.6701	***	-2469869.6214	-11.1718	***
20	ACEH-SULAWESI UTARA	-237396.2864	-2.8543	**	-721385.3014	-12.8970	***
21	ACEH-SULAWESI TENGAH	76417.9836	1.0587	***	-157893.3229	-5.8750	***
22	ACEH-SELAWESI SELATAN	-1453950.4118	-13.4577	***	-2728169.8114	-9.2804	***
23	ACEH-SULAWESI TENGGARA	186667.2073	3.0207	**	-31965.3186	-1.2289	
24	ACEH-MALUKU	-16148.4536	-0.2638		251807.0500	16.2254	***
25	ACEH-PAPUA	-88930.1818	-0.5922		-154502.5100	-1.8361	

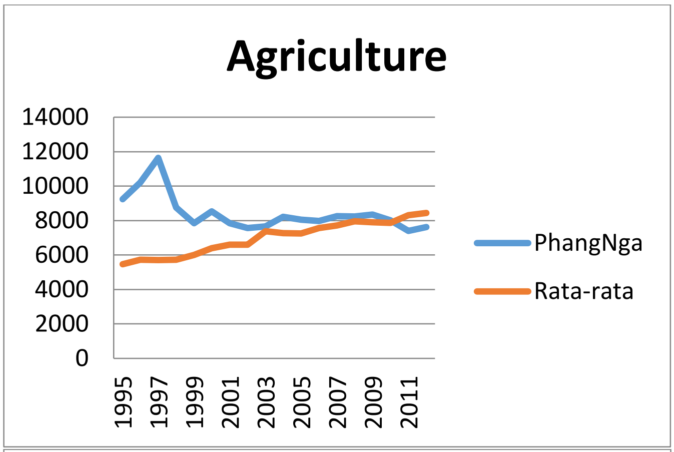
(, **, * untuk level signifikansi 1%, 5% dan 10%***

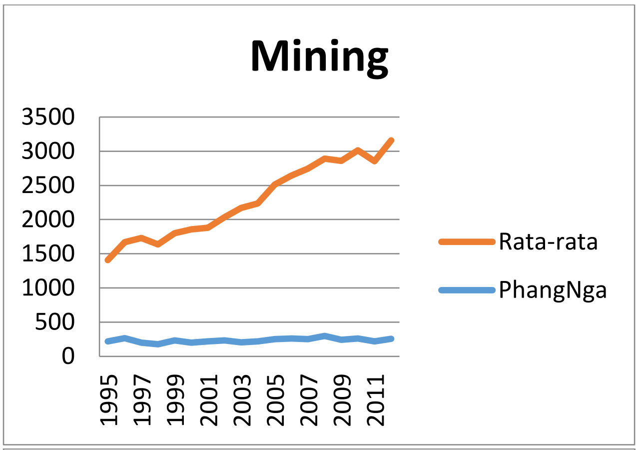
Tabel A15. Hasil uji beda berpasangan untuk sektor jasa

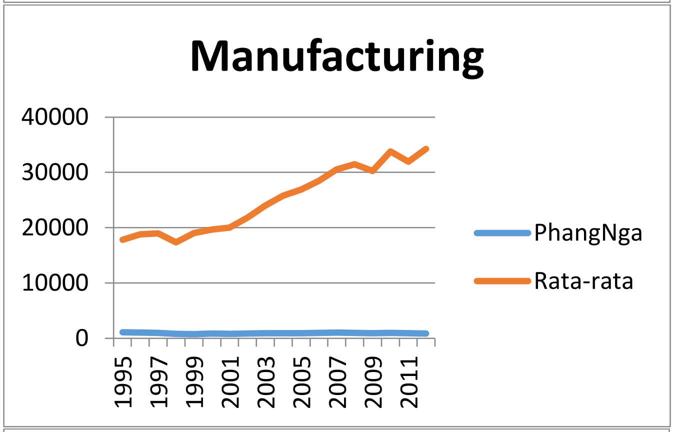
		Sebelum Tsunami			Sesudah Tsunami		
		rata-rata	t test		rata-rata	t test	
1	ACEH-SUMATERA UTARA	-3893840.1722	-20.5915	***	-4989367.1143	-12.0391	***
2	ACEH-SUMATERA BARAT	-1799476.0718	-9.1835	***	-271842.6571	-2.5108	**
3	ACEH-RIAU	225001.8609	4.6541	***	295148.0571	1.9675	*
4	ACEH-JAMBI	1671471.3718	12.7472	***	4156175.5000	22.7432	***
5	ACEH-SUMATERA SELATAN	-891693.2491	-5.7376	***	125152.6143	0.7830	
6	ACEH-BENGKULU	1729417.9845	11.1819	***	4255942.4000	25.9141	***
7	ACEH-LAMPUNG	314312.7264	1.7732		2860164.4857	21.7042	***
8	ACEH-DKI JAKARTA	-23183251.6264	-31.4776	***	-35567833.3857	-19.4668	***
9	ACEH-JAWA BARAT	-17628895.6800	-12.8205	***	-17649957.7143	-20.4850	***
10	ACEH-JAWA TENGAH	-12632186.4191	-11.8137	***	-11684624.3429	-20.5878	***
11	ACEH- D I YOGYAKARTA	-775579.7091	-2.2364	**	2344541.7571	26.6362	***
12	ACEH-JAWA TIMUR	-20711661.9573	-15.5663	***	-21543310.9857	-15.5835	***
13	ACEH-BALI	-837093.7464	-2.2231	**	1938671.9857	23.9876	***
14	ACEH-NUSA TENGGARA BARAT	908365.3473	4.1477	***	3709052.0571	24.2094	***
15	ACEH-NUSA TENGGARA TIMUR	807374.2020	4.7985	***	2748423.9571	28.7196	***
16	ACEH-KALIMANTAN BARAT	333269.9582	1.1983		2402648.4714	42.2414	***
17	ACEH-KALIMANTAN TENGAH	1369157.4500	9.3018	***	3376152.0571	28.5152	***
18	ACEH-KALIMANTAN SELATAN	890735.2536	5.4764	***	3027193.8000	28.9378	***
19	ACEH-KALIMANTAN TIMUR	1104995.2091	6.9867	***	3430770.0429	25.1125	***
20	ACEH-SULAWESI UTARA	542919.0155	4.1307	***	2550451.4714	25.5471	***
21	ACEH-SULAWESI TENGAH	1408772.4682	15.6411	***	3087146.2429	45.2882	***
22	ACEH-SELAWESI SELATAN	-1478296.7436	-6.9569	***	-83898.1429	-0.9623	
23	ACEH-SULAWESI TENGGARA	1782093.0600	14.3225	***	4203014.0000	23.7062	***
24	ACEH-MALUKU	1796090.2373	10.2771	***	4568202.2000	23.7874	***
25	ACEH-PAPUA	1191738.5064	7.3345	***	2921979.7286	26.6573	***

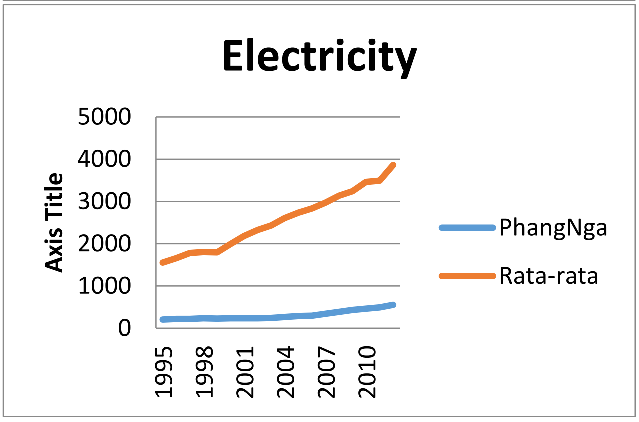
(, **, * untuk level signifikansi 1%, 5% dan 10%***

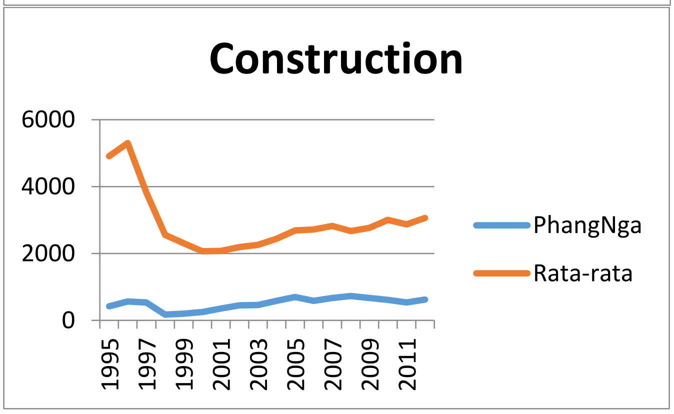
Lampiran B.Statistik Descriptive untuk Provinsi Phang Nga

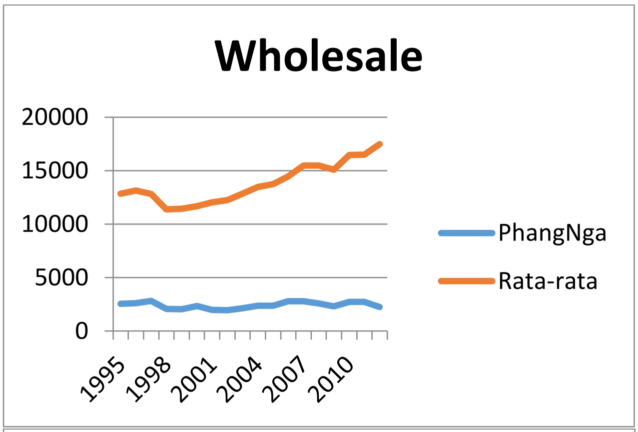


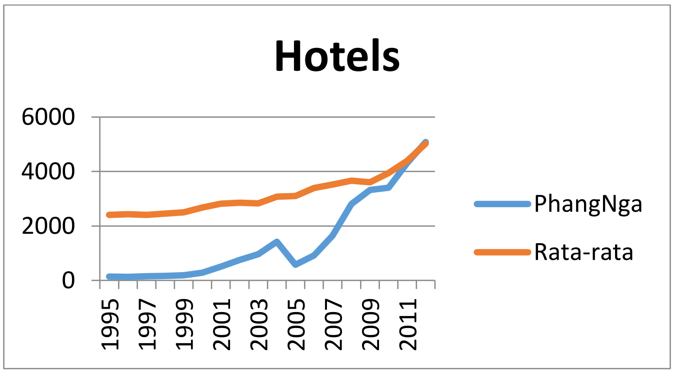


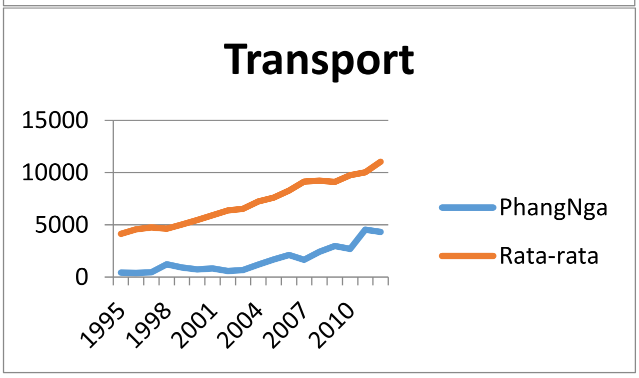


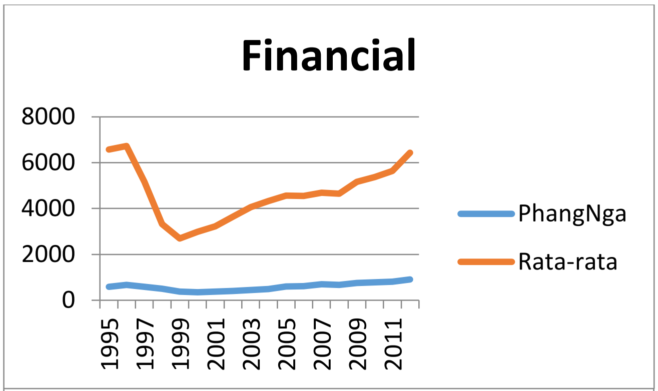


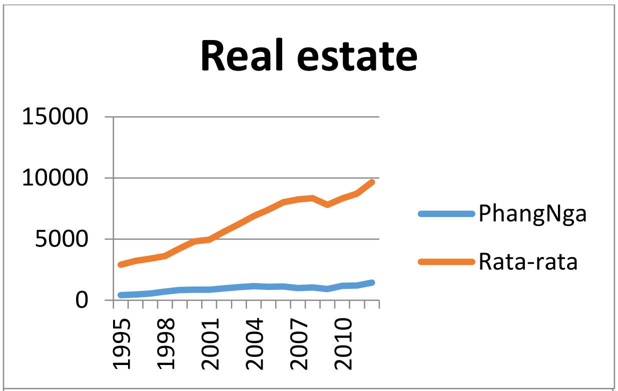


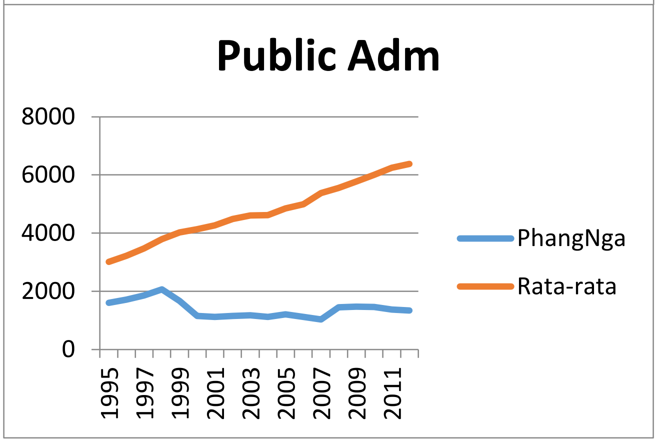


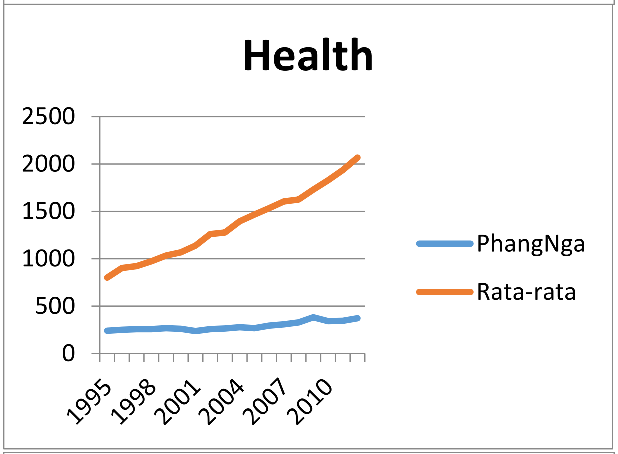


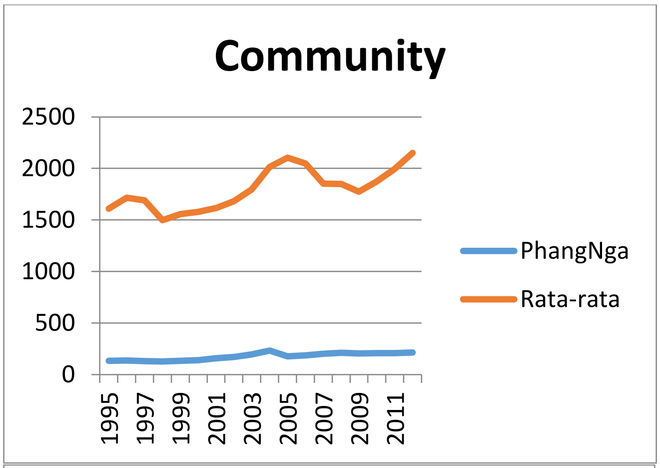


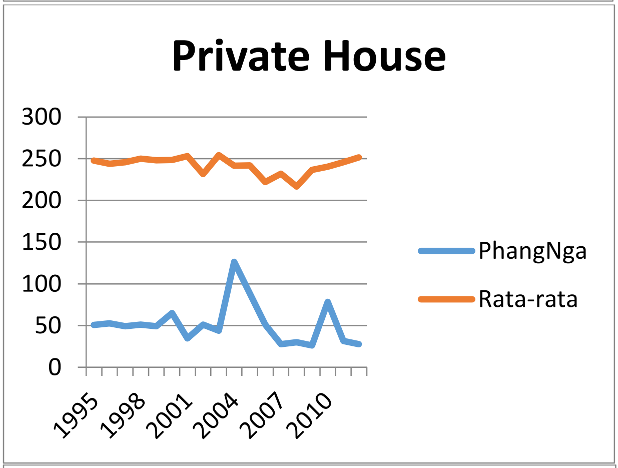

Financial
8000
6000
4000
2000
0
1995
1997
1999
2001
2003
2005
2007
2009
2011
PhangNga
Rata-rata

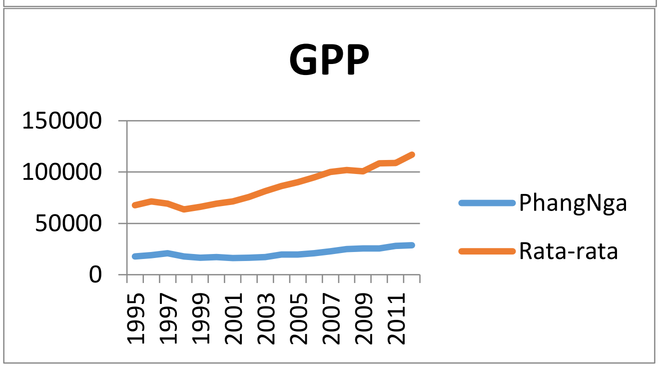

Real estate
15000
10000
5000
0
1995
1998
2001
2004
2007
2010
PhangNga
Rata-rata

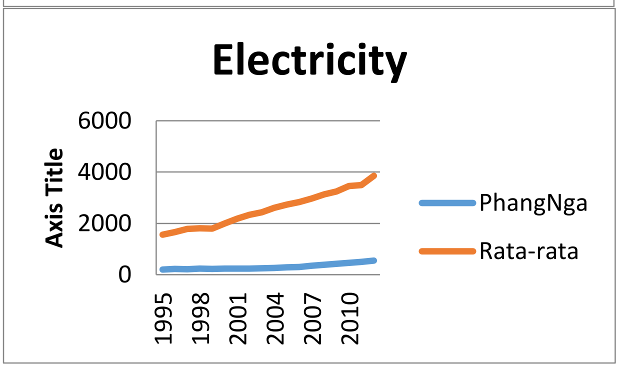

Public Adm
8000
6000
4000
2000
0
1995
1997
1999
2001
2003
2005
2007
2009
2011
PhangNga
Rata-rata

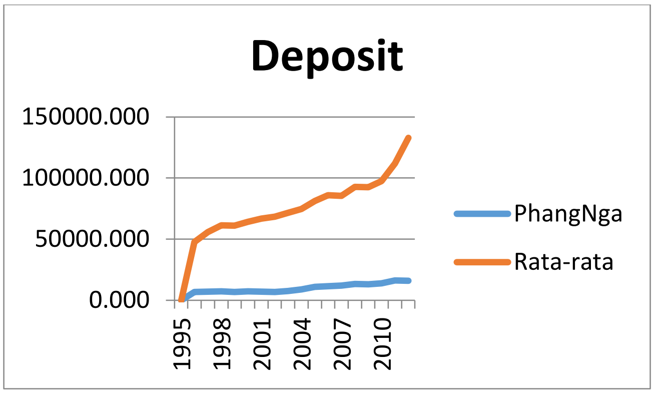

Health
2500
2000
1500
1000
500
0
1995
1998
2001
2004
2007
2010
PhangNga
Rata-rata


Community
2500
2000
1500
1000
500
0
1995
1997
1999
2001
2003
2005
2007
2009
2011
PhangNga
Rata-rata


Private House
300
250
200
150
100
50
0
1995
1998
2001
2004
2007
2010
PhangNga
Rata-rata


GPP
150000
100000
50000
0
1995
1997
1999
2001
2003
2005
2007
2009
2011
PhangNga
Rata-rata


Electricity
Axis Title
6000
4000
2000
0
1995
1998
2001
2004
2007
2010
PhangNga
Rata-rata


Deposit
150000.000
100000.000
50000.000
0.000
1995
1998
2001
2004
2007
2010
PhangNga
Rata-rata

Lampiran C: Hasil Synthetic Control untuk Provinsi Phang Nga dan Kamphaeng Phet

Tabel C1. Hasil Synthetic Control untuk Provinsi Phang Nga untuk masing-masing variabel dependen

Province	GRDP_Cap	Agriculture	Manufacture	Utilities	Construction	Trading	Tourism	Transportation
Amnat Charoen	0	0	0	0	0	0	0	0
Ang Thong	0	0	0	0	0	0	0	0.039
Buri Ram	0	0	0	0	0	0	0	0
Chachoengsao	0	0	0	0	0.11	0	0	0
Chai Nat	0	0	0	0	0	0	0	0
Chaiyaphum	0	0	0	0	0	0	0	0
Chanthaburi	0	0	0	0	0	0	0	0
Chiang Mai	0	0	0	0	0	0	0	0.05
Chiang Rai	0	0	0	0	0	0	0	0
Chon Buri	0	0	0	0	0	0	0	0
Chumphon	0.037	0	0	0	0.007	0	0.019	0
Kalasin	0.228	0.354	0.354	0.152	0.139	0.115	0.109	0
Kamphaeng Phet	0.566	0.003	0.003	0.131	0.316	0	0.57	0.125
Kanchanaburi	0	0	0	0	0	0	0	0
Khon Kaen	0	0	0	0.005	0	0	0	0
Krabi	0	0	0	0	0	0	0	0
Lampang	0	0	0	0	0	0	0	0
Lamphun	0	0	0	0	0	0	0	0
Loei	0	0	0	0	0	0	0	0
Lop Buri	0	0	0	0	0	0	0	0
Mae Hong Son	0	0	0	0.088	0.007	0	0.116	0
Maha Sarakham	0	0	0	0	0	0	0	0
Mukdahan	0	0	0	0	0	0	0	0
Nakhon Nayok	0	0	0	0	0	0	0	0
Nakhon Pathom	0	0	0	0	0	0	0	0
Nakhon Phanom	0	0	0	0.003	0	0	0.001	0.003
Nakhon Ratchasima	0	0	0	0	0	0	0	0
Nakhon Sawan	0	0	0	0	0	0	0	0
Nakhon Si Thammarat	0	0	0	0	0	0	0	0.001
Nan	0	0	0	0	0	0	0	0
Narathiwat	0	0	0	0	0	0	0	0
Nong Bua Lam Phu	0	0	0	0	0	0	0	0
Nong Khai	0.124	0.163	0.163	0.068	0.001	0	0.023	0.001
Nonthaburi	0	0.119	0.119	0	0	0	0	0.018
Pathum Thani	0	0	0	0	0	0.047	0	0
Pattani	0	0	0	0	0	0	0	0
Phangnga	0	0	0	0	0	0	0	0
Phatthalung	0	0	0	0	0	0	0	0

Tabel C1… Lanjutan

Province	Finance	Housing	Public	Education	Health	Service	HouseHold
Amnat Charoen	0	0	0	0	0	0	0
Ang Thong	0	0	0.071	0	0	0	0.019
Buri Ram	0	0	0	0	0	0	0
Chachoengsao	0	0	0	0	0	0	0
Chai Nat	0	0	0	0	0	0	0
Chaiyaphum	0	0	0	0	0	0	0
Chanthaburi	0	0	0	0	0	0	0
Chiang Mai	0	0	0	0	0	0	0
Chiang Rai	0	0	0	0	0	0	0
Chon Buri	0	0	0	0	0	0	0
Chumphon	0.002	0	0	0	0.11	0	0
Kalasin	0.104	0	0	0.003	0.001	0.219	0.042
Kamphaeng Phet	0.086	0.292	0.083	0.541	0.123	0.132	0.181
Kanchanaburi	0	0	0	0	0	0	0
Khon Kaen	0	0	0	0.023	0.085	0	0.108
Krabi	0	0	0	0	0	0	0
Lampang	0	0	0	0	0	0	0
Lamphun	0	0	0	0	0	0	0
Loei	0	0	0	0	0	0	0
Lop Buri	0	0.043	0	0	0	0	0
Mae Hong Son	0	0	0	0	0	0	0
Maha Sarakham	0	0	0	0	0	0	0
Mukdahan	0	0	0	0	0	0	0
Nakhon Nayok	0	0	0	0	0	0	0
Nakhon Pathom	0	0	0	0	0	0	0
Nakhon Phanom	0.049	0	0	0	0	0.001	0
Nakhon Ratchasima	0	0	0	0	0	0	0
Nakhon Sawan	0	0	0	0.138	0.117	0	0
Nakhon Si Thammarat	0	0	0	0	0	0	0
Nan	0	0	0	0	0	0	0
Narathiwat	0	0	0	0	0	0	0
Nong Bua Lam Phu	0	0	0	0	0	0	0
Nong Khai	0.14	0	0	0	0	0	0.251
Nonthaburi	0	0	0.098	0	0	0	0
Pathum Thani	0	0	0	0	0	0	0
Pattani	0	0	0	0	0	0	0
Phangnga	0	0	0	0	0	0	0

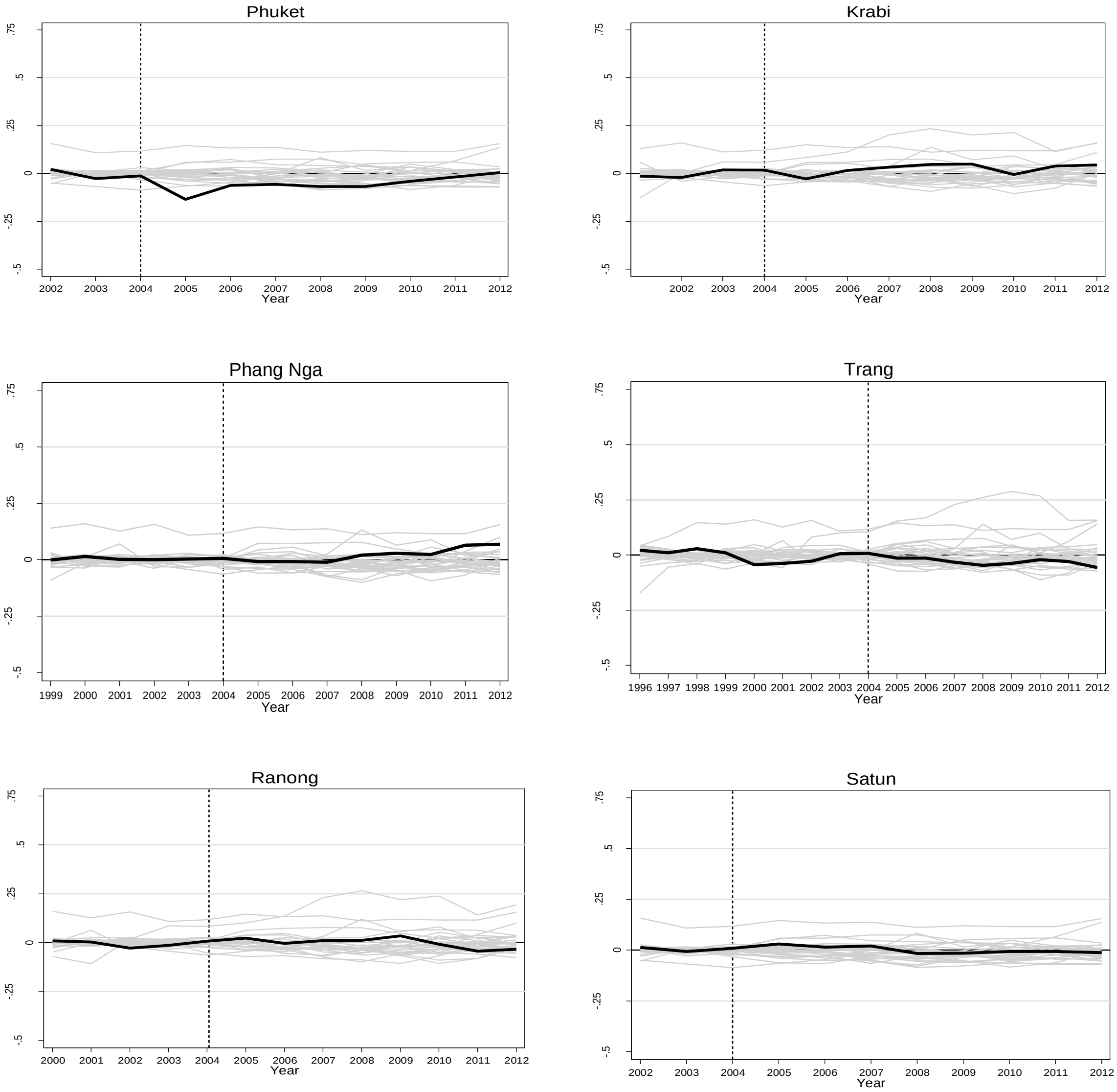
Tabel C2. Hasil Synthetic Control untuk Provinsi Khamphaeng Phet untuk masing-masing variabel dependen

Province	GRDP_Cap	Agriculture	Manufacture	Utilities	Construction	Trading	Tourism	Transportation
Phayao	0	0	0	0	0	0	0	0
Phetchabun	0	0	0	0	0	0	0	0
Phetchaburi	0	0	0	0	0	0	0	0
Phichit	0	0	0	0	0	0	0	0
Phitsanulok	0	0.001	0.001	0.017	0	0.031	0.004	0.053
Phra Nakhon Si Ayutthaya	0	0	0	0	0	0	0	0
Phrae	0	0	0	0	0	0.002	0	0
Phuket	0	0	0	0	0	0	0	0
Prachin Buri	0	0	0	0	0	0	0	0
Prachuap Khiri Khan	0	0	0	0	0	0	0	0
Ranong	0	0	0	0	0	0	0	0
Ratchaburi	0	0	0	0	0.131	0	0	0
Rayong	0	0	0	0	0	0	0	0
Roi Et	0	0	0	0	0	0	0	0
Sa Kaeo	0	0	0	0	0	0	0	0
Sakon Nakhon	0	0	0	0	0	0	0	0
Samut Prakan	0	0	0	0	0	0	0	0
Samut Sakhon	0	0	0	0	0	0	0	0
Samut Songkhram	0	0	0	0	0	0	0	0
Saraburi	0	0	0	0	0	0	0	0
Satun	0	0	0	0	0	0	0	0
Si Sa Ket	0	0	0	0	0	0	0	0
Sing Buri	0.001	0	0	0	0.144	0	0	0
Songkhla	0	0	0	0	0	0.104	0	0.008
Sukhothai	0.003	0.209	0.209	0.119	0	0.43	0.1	0.222
Suphan Buri	0.001	0	0	0.016	0	0	0	0
Surat Thani	0	0	0	0	0	0	0	0
Surin	0	0	0	0	0	0	0	0
Tak	0	0	0	0	0	0	0	0
Trang	0	0	0	0	0	0	0	0
Trat	0.039	0.018	0.018	0.075	0	0.271	0	0.48
Ubon Ratchathani	0	0	0	0	0	0	0	0
Udon Thani	0	0	0	0	0	0	0	0
Uthai Thani	0	0.131	0.131	0.324	0.147	0	0.057	0
Uttaradit	0	0	0	0	0	0	0	0
Yala	0	0	0	0	0	0	0	0
Yasothon	0	0	0	0	0	0	0	0

Tabel C2. Lanjutan

Province	Finance	Housing	Public	Education	Health	Service	HouseHold
Phatthalung	0	0	0	0	0	0	0
Phayao	0	0	0	0	0	0	0
Phetchabun	0	0	0	0	0	0	0
Phetchaburi	0	0	0	0	0	0	0
Phichit	0	0	0	0	0	0	0
Phitsanulok	0	0	0	0	0.05	0.131	0
Phra Nakhon Si Ayutthaya	0	0	0	0	0	0	0
Phrae	0	0	0	0	0	0	0
Phuket	0	0	0	0	0	0	0
Prachin Buri	0	0	0	0	0	0	0
Prachuap Khiri Khan	0	0	0	0	0	0	0
Ratchaburi	0	0	0	0	0	0	0
Rayong	0	0	0	0	0	0	0
Roi Et	0	0	0	0	0	0	0
Sa Kaeo	0	0	0	0	0	0	0
Sakon Nakhon	0	0	0	0	0	0	0
Samut Prakan	0	0	0.149	0	0	0	0
Samut Sakhon	0	0	0	0	0	0	0
Samut Songkhram	0	0	0	0	0	0	0
Saraburi	0	0	0	0	0	0	0
Satun	0	0	0	0	0	0	0
Si Sa Ket	0	0	0	0	0	0	0
Sing Buri	0	0	0	0.065	0.002	0	0
Songkhla	0	0	0	0	0	0	0
Sukhothai	0.001	0	0.435	0	0.188	0.085	0
Suphan Buri	0.046	0	0	0	0	0.026	0
Surat Thani	0	0	0	0	0	0	0
Surin	0	0	0	0.194	0	0	0
Tak	0	0.572	0	0	0.002	0	0
Trang	0	0	0	0	0	0	0
Trat	0.193	0	0.15	0.034	0.321	0.406	0.364
Ubon Ratchathani	0	0	0	0	0	0	0
Udon Thani	0	0	0.015	0	0	0	0
Uthai Thani	0.378	0.093	0	0.001	0	0	0.034
Uttaradit	0	0	0	0	0.001	0	0
Yala	0	0	0	0	0	0	0
Yasothon	0	0	0	0	0	0	0

Lampiran D. Hasil Studi Placebo untuk Thailand



Lampiran E1. Naskah untuk Publikasi di Bulletin of Indonesian Economic Studies (BIES)

How Resilient is the Economy to a Catastrophic Natural Disaster? Lessons Learned from a Developing Country*

Inggrid†
Siana Halim‡

Abstract

Recent research in developed countries shows an adverse effect of natural disasters on the economy. This paper seeks to examine whether this is also relevant for developing countries. Applying a counterfactual approach to Indonesian sub-national data, we find that the Indian Ocean tsunami of 2004 negatively affects the regional income per capita of the exposed region. This result seems straightforward to reconcile with previous evidence using developed countries data. However, we are able to highlight that it becomes more pronounced in low-income economies. The pro-cyclical fiscal behaviours in the aftermath of disaster events and the non-trivial inter-sectoral linkages in the economic structure of developing countries provide two plausible explanations for this finding.

Keywords: natural disaster, economic impact, developing country
JEL codes: O1, O4, Q54

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1. INTRODUCTION

We were writing the final part of this paper when the deadly Typhoon Haiyan just buffeted the Philippines on November 8, a few days before the annual United Nations Climate Change summit (COP19) took place in Warsaw. The natural catastrophe was estimated to kill over 5,500 people and has caused a trail of destruction across the country. The Super-typhoon Haiyan reached Vietnam in the following day and forced the Vietnamese government to evacuate more than 600,000 people. Although there was no special dialogue about the disaster, the conference calls for the worldwide response to global warming.

So far, what can be inferred is that natural disasters cause sizeable economic losses. Unsurprisingly, low- and middle-income economies have to incur larger burdens because these two groups typically experience more frequent and more destructive disasters than high-income countries. Recent research also shows a Kuznets inverted-U type relationship between economic development and disaster damages, suggesting that the loss from disasters increase at a relatively low level of gross domestic product (GDP) per capita, but it starts decreasing once a country becomes richer beyond the turning point (Kellenberg and Mobarak 2008; Kellenberg and Mobarak 2011). The existing experiences validate this hypothesis. For instance, the economic costs from the Sendai earthquake and tsunami in 2011 were estimated to correspond to 4% of Japan's GDP, whereas in a developing country, like Haiti, the disaster costs accounted for about 120% of the country's GDP in 2010. These stylised figures, however, are predicted to increase continuously since the exposure to disasters is even higher as a consequence of the rapid growth in global population, poor management of natural resources, and climate variability (World Bank and GFDRR 2012).

This paper assesses the indirect economic costs of a large-scale natural disaster in a large developing country. We take a direct example of the 2004 Aceh tsunami in Indonesia. One day after Christmas in 2004 at 00.59 GMT, a 9.0 Richter-magnitude earthquake hit the west coast of Sumatra, a major island in the western part of Indonesia. It subsequently generated ferocious tsunami waves in the provinces of Aceh and North Sumatra with the latter warranted minor devastations. This catastrophic event is considered as one of the worst tsunamis in human history. According to the official statistics, the death toll of the Aceh tsunami was more than 165,000 people and over a half million people were displaced. The total estimate of economic damages and losses was approximately $4.5 billion which was equivalent to 97.4% of Aceh's GDP in 2003 (Athukorala and Resosudarmo 2005; Athukorala 2012).

Our identification strategy relies on the natural experiment generated by the tsunami. This disaster presumably is an exogenous shock to Aceh and to the magnitude of damage unleashed even though the tsunami is not entirely a random event to the province. Hence, we believe that the aforementioned natural hazard is a suitable treatment to compare output dynamics of Aceh (i.e. the treatment group) ***vis-à-vis*** the other unexposed provinces (i.e. the control group). In practice, however, our estimation cannot be performed straightforwardly since it is very likely that the provinces in the comparison group grew much faster compared to Aceh in the absence of the tsunami. In this case, although employing the conventional micro-econometric methods, like the difference-in-differences (DiD) estimator, will help us to eliminate unobservable time-invariant characteristics of the two groups, we aware that our estimates will be biased because the average outcomes in the treatment and control groups do not satisfy the common trend assumption.

To address the above limitations, instead, we apply the synthetic control method (SCM) recently developed by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010). SCM is an extension of the standard DiD. The method is less stringent with respect to the parallel trend assumption and allows for the presence of unobservable time-variant provinces characteristics. By employing SCM, we construct the counterfactual outcome of Aceh or the synthetic control of Aceh. Basically, it is a weighted combination of the unexposed provinces that resembles Aceh in terms of its pre-disaster economic characteristics. We estimate the economic effects of the tsunami by comparing the differential outcomes between the actual and synthetic control of Aceh.

Our current experiment provides an exceptionally challenging case to study disaster-related economic impacts. Prior to the occurrence of the disaster, the economy of Aceh might have been distorted due to the long-lasting conflict with the Free Aceh Movement (GAM) which sought to establish an independent country.[1] As a matter of fact, a series of attempts to make peace was conducted. The most notable result was the both sides agreed to sign a Cessation of Hostilities Agreement (COHA) in 2002 (Aspinall 2005). The deal with this, we perform the SCM algorithm twice, one using full sample (the period 1995-2011) and the other starting from 2002. We begin our sample in the period in which the credible truce had only just begun since Abadie and Gardeazabal (2003) demonstrate the predictive power of ceasefires on the economic performance. They conclude that the credible ceasefire declared by ETA is proven to have a positive impact on the market value of Basque stocks. We are also concerned with the Big Bang decentralisation in 2001, while the Government of Indonesia (GoI) granted special autonomy to Aceh. The law lets the province to receive a generous share of oil and gas revenues which stimulates the local economy. We adopt the same strategy to account for the second caveat.

The credibility of our study is also dependent crucially on the fulfilment of Stable-Unit-Treatment-Value assumption (SUTVA), meaning that the control units should be unaffected by the tsunami. An obvious difficult choice is whether or not to include neighbouring provinces to construct a suitable comparison group for Aceh. To some extent, neighbours typically have the same socioeconomic and structural characteristics as the affected unit, and thus they are most likely to be important donors to the synthetic controls. On the other side, we cannot easily check the spill over effects of the Aceh's tsunami on the economy of North Sumatra province which shares the same border with Aceh. Additionally, North Sumatra also experiences the disaster shock. To increase validity of this study, we first include North Sumatra in the donor pool and carry out robustness tests without including this province.

In general, we find negative and large effects of the tsunami on Aceh's GDP per capita. This is consistent with the findings of duPont and Noy (forthcoming) which use the identical empirical strategy to estimate the economic consequences of the Kobe earthquake in 1995. While ***duPont*** and Noy estimate the effect of the earthquake on Kobe's GDP per capita is about 9%, our empirical estimates reveal that, on average, Aceh's GDP per capita was about 29.67% lower than it would have been had the tsunami not occurred. The results from the placebo tests also signify the validity of our estimates. We argue that the pro-cyclical fiscal behaviours in the aftermath of disaster events along with the nontrivial inter-sectoral linkages in the economic structure of developing countries may serve as two probable reasons why developing countries have to undergo greater economic losses from natural disasters than do developed countries.

To sum up, this current work enriches fairly limited study available on the economics of natural disasters by providing robust and new insights into the economic consequences of natural disasters in developing countries. A comparison with the study based on developed country data gives support to the disaster theory about non-linearities in the association between and a country's income per capita disaster shocks.

The remainder of this paper is structured as follows. Section 2 outlines theories and evidence on the economic effects of natural disasters. Section 3 describes some background on the 2004 Indian Ocean Tsunami in Indonesia and Aceh's economy. Section 4 gives an overview of central identifying assumptions and provides the empirical methodology. Section 5 presents the empirical results and a number of robustness tests, and followed by discussion of the main findings. Section 6 concludes.

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[1] Research on political conflicts has noted economic consequences of terrorisms. For example, the highly cited literature in the causal effects of terrorism in the Basque country reveals that the terrorist organisation ETA's activity leads to a 10% drop in GDP per capita of the Basque country (Abadie and Gardeazabal 2003).

2. THE GROWTH EFFECTS OF NATURAL DISASTERS: THEORIES AND EMPIRICAL EVIDENCE

There has been a burgeoning literature on the economic consequences of natural disasters over the last few decades. Among economic variables, the evolution of gross domestic product (GDP) is predominantly analysed in the study of natural disasters-related impacts, whereas the mechanics of disaster-GDP dynamic nexus are best explained by growth theories at the theoretical level.[2] To apply these theoretical frameworks into analysis, we assume that a natural disaster is an exogenous shock, and it will change the stock of physical and human capital in the economy.

We begin our understanding with exogenous growth theories, like the Solow-Swan neo-classical model where the rate of saving is introduced as an exogenous factor. The model demonstrates that the destruction of capital and human capital following natural disasters will temporarily faster economic growth because it will drive the economy further away from its steady state. Once the economy returns to the long-run equilibrium condition, it goes back on the balanced growth pathway.

Drawing on the traditional Solow-Swan model, Loayza et al. (2012) further elucidate the underlying channels through which natural disasters may affect the balanced growth path. The main possible way is through a decrease in total factor productivity (TFP) as a response of natural disasters, leading to a drop in the average product of capital for each level of capital per worker and contract the economy. The next argument is related to a reduction in the supply of raw materials and intermediate inputs that gives tantamount growth implications. The final route is the ratio of capital-labour. When natural disasters devastate capital, especially physical capital, they are likely to promote growth.

The second branch of literature uses endogenous growth models which have quite different testable empirical predictions of disaster effects on growth. The Schumpeterian creative destruction model of endogenous growth suggests favourable disaster impacts. It models that natural disaster shocks can stimulate the affected economy to replace the destroyed capital with the most advanced technology of capital that further improve the long-run economic productivity. Another variant of endogenous growth theories based on constant returns to capital claims negligible the growth rate of output as a result of a negative capital stock. Nevertheless, this AK model underlines that an economy subjected to destruction of capital will never revert back to its pre-disaster growth path. While we presume increasing returns to scale in the production function, however, capital losses whenever there is an onset of disasters will yield a permanent and an adverse effect on growth trajectories. The Uzawa-Lucas of the two-sector endogenous model provides less clear-cut theoretical predictions to what extent an economy will react to such an event. The growth rate of output goes down if a natural disaster damages the human capital per se. On the contrary, a natural disaster is expected to promote economic growth if it destroys the largest part of the physical capital.

What do empirical studies tell us about the macroeconomic aspects of natural disasters? Utilising a panel dataset for 26 countries during the 1960-1979 periods and collecting 28 types of disaster events, the classic work of Albala-Bertrand (1993) finds support for the Schumpeterian creative destruction process. Specifically, he notes that GDP increases faster after the onset of natural disasters. The subsequent studies by Okuyama (2003) and Benson and Clay (2004) also point to the important role of the productivity effects in explaining a positive effect of disasters on economic activities.

Cuaresma, Hlouskova and Obersteiner (2008) regress the evolution of R&D from foreign origin and natural catastrophic risk in attempt to carefully re-examine the creative destruction dynamic. Condition on high levels of development, their econometric

[2] We review the underlying theoretical models of growth trajectories in the aftermath natural disasters from Noy and Nualsri (2008).

estimates imply that natural disasters are more likely to reinforce the degree of knowledge spillovers which in turns determine growth patterns as a sound theoretical prediction of endogenous growth theory. Hallegatte and Dumas (2009) use a calibrated endogenous growth model to systematically test this theoretical prediction. The findings of the study, however, do not contradict the theoretical prediction.

Skidmore and Toya (2002) find somewhat counterintuitive findings. They also run cross-country growth regressions to examine the long-run response of growth to natural disasters. Their research comes to a conclusion on heterogeneous effects of natural disasters, depending on geographical regions, sectors, and different types of disasters. For instance, climatic disasters are positively associated with average per capita GDP growth, whereas geological disasters are inversely related with growth. Exploiting the within-country and time series variation and making a strong assumption of exogenous disaster shocks, Raddatz (2009) sheds further light on the differential effects of natural disasters on GDP. His study suggests a climatic disaster lowers GDP per capita by approximately 0.6% in the long-run, while droughts produce the largest effect which account for 1% cumulative losses of GDP per capita. In addition, the work does not indicate a significant role of geological disasters in determining changes to output either in the short- or the long-run. Yet, the author highlights that the macroeconomic performance of low-income countries is more strongly affected by catastrophes than among middle and high income economies.

Loayza et al. (2012) also address the heterogeneity of disaster effects. They document strong evidence that droughts and storms obviously hamper agricultural growth in developing countries. On the opposite, the authors underpin beneficial effects of floods to output growth. The authors argue they happen through several mechanisms. Droughts and storms potentially shrink agricultural productivity since both disasters destroy agricultural infrastructure (e.g. dams, irrigation channels). The other plausible pathway is that droughts and storms cut down the availability of inputs (e.g. water, seedling or un-harvested agricultural products). These, not surprisingly, are translated to lower growth. Turning to floods, Loayza et al. interpret that the disasters supply water for irrigation given they are localised. Hence, they provoke agricultural growth.

The paper by Noy (2009) is particularly close to Raddatz's in spirit, but it takes into account the structural and institutional aspects of the economy into the analysis. Under the strict exogeneity assumption of natural disasters, his investigation emphasises that a country's GDP growth is more robust to disaster shocks when the country adopts less-open capital accounts, is able to accumulate large foreign exchange reserves, and experiences genuine financial deepening.

The latest research by McDermott, Barry and Tol (forthcoming) also considers the role of financial markets in catalysing economic growth following a disaster. They develop a simple two-period model of an economy with borrowing constraints and collect panel data of low-income economies to examine the predictions of their theoretical model. The findings further bolster the exiting findings that natural disasters lead to a significant negative effect on economic growth. Yet, the effects will be aggravated and be long-lasting in an economy with credit constraints. The intuition of the model is unambiguous: a disaster shock will be translated to lower household income and to decrease levels of investment, and eventually reducing economic growth potential over the long-term.

Cavallo et al. (forthcoming) also apply the synthetic control method to figure out the trajectory of GDP of the disaster affected country. They do not find economically and statistically significant effects of large disasters on the long-term GDP growth. When they incorporate radical political upheavals in the model, they stress that the occurrence of disasters can lower GDP growth by an average of 10% in the long-run. Furthermore, this result should be interpreted with caution since the authors are unable to disentangle the political revolution influences from the disaster effects on GDP.

In some contexts, conducting a cross-country study and multiple-disaster analysis to assess the actual size of those events gives rise to several problems. First, different types of natural disasters arguably yield different effects to the economy, and they also vary with respect to a country's level of development. Hence, it is implausible to assume homogeneity of disaster effects across countries. Second, the lack of standardised and high-quality data undermines attractive features of multi-country studies (Strobl 2012).

Constructing novel hurricane disaster indexes and concentrating on the sample of the Central America and Carribean (CAC) regions, Strobl (2012) contributes to the literature of disaster impacts in developing countries by providing new evidence on the negative economic impacts of hurricane disasters. A case study from Vietnam further underscores the variability of disasters to macroeconomic dynamics. Using more detailed panel data at the provincial level, the work reveals weak growth rates of disaster-affected regions if natural disasters become deadlier. On the other side, any disaster events that primarily devastate physical capital are positively associated with economic growth in the short-run as the mechanic of the creative destruction hypothesis. The other emerged pattern is that more developed regions give rise to faster growth recovery than poor and backward regions following the onset of disasters. This can be explained by the fact that the former regions have better access to reconstruction funds and are able to benefit from capital upgrading (Noy and Vu 2010).

Likewise, numerous papers have assessed a particular disaster impact on a specific economy. For example, Horwich (2000) and Chang (2010) focus on the Kobe earthquake in 1995. Although the former does not note a long-lasting adverse economic impact of the earthquake, the second documents contradictory results. In spite of that, it is very important to bear in mind that the research design is just simply before-after the quake, and the identification strategy does not account for post-disaster shocks (such as the prolonged economic recession since 1989) which inevitably affect the Japan's economy.

Lately, Coffman and Noy (2012) only focus on a single impact of hurricane, that is, Hurricane Iniki which hit the Hawaiian Islands of Kauai. They exploit Kauai's similarity to the other Hawaiian Islands in terms of their economic characteristics and run the synthetic control method algorithm to examine the long-term economic impacts of the disaster. Their empirical findings lend support to detrimental and prolonged economic effects of the Iniki disaster, albeit the fact that the region receives a huge fiscal stimulus from the fiscal authority.

3. THE 2004 INDIAN OCEAN TSUNAMI AND ACEH'S ECONOMY

Our setting is the Aceh Province of Sumatra. This province is very prone to disasters as it is located within the Alpide belt and is directly opposite to the Indian Ocean. The devastating earthquake of 26 December 2004 occurred when the Indian Plate was sub-ducted below the overriding Burma Plate and triggered tsunamis along coastal areas around the Indian Ocean.

It was at 07.58 a.m. local time, when a powerful earthquake with magnitude of 9.0 on the Richter scale struck Sumatra Island of western Indonesia. The earthquake subsequently followed by tremendous tsunami waves, yielding the tallest wave as high as 24.4 meters. The tsunami totally slammed Aceh, the closest area to the epicentre of the earthquake, whereas the Nias and Simeulue islands of North Sumatra Province were less affected. The successive tsunami surge spread out quickly to other countries in the continent of Asia and Africa, leading to a massive global natural disaster (Athukorala and Resosudarmo 2005).[3]

By mid 2005, it was reported that the number of deaths caused by the Aceh disaster

[3] It moved to the west, hitting coastal areas of the other Asia countries (India, Malaysia, Maldives, Myanmar Srilanka, and Thailand) and several African countries (Kenya, Somalia, and Tanzania). Srilanka was the worst affected country among them.

exceeded 165,000 people, constituting over 70% of the total death toll, and more than 500,000 people were displaced. The total estimate of economic damages and losses was unprecedented, about $4.5 billion, corresponding to 97.4% of Aceh's GDP in 2003. The total cost of the property destruction itself, including housing and infrastructure, was approximately $1.5 billion. The process of recovery and reconstruction programs was completely finalised by mid 2010, pooling substantial funds by the Government of Indonesia and major aid agencies (Athukorala 2012).

Turning to the economy, even though Aceh's economy is considerably small compared to the other provinces, Aceh is endowed with abundant liquefied natural gas (LNG) which had a long history of civil conflicts for almost three decades. Between the late 1970s and the 1980s, together with the LNG boom, the province showed exceptional economic performance which was characterised by high growth across all sectors. The agriculture sector grew at an average rate of 7.6% per year from 1975 to 1984, whereas the manufacturing sector recorded a remarkable growth of 13.70% during the same time period. The share of oil and gas in the province's GDP also increased dramatically from less than 17% in 1976 to roughly 69.50% in 1989. Acehnese enjoyed by far the prosperity of the oil and gas boom with the incidence of poverty was among the lowest rates in the country, just below 2% in 1980.

Keeping pace with the national economy, the regional economy in Aceh continued its impressive growth during 1989-1996. Nevertheless, the unemployment rate soared because of the economic collapse in the late 1990s, with the size of the official labour force fell to 37.35% in 1998. It is worthwhile to mention that the economic and financial crises were less severe in Aceh than they were in the rest of Indonesia. Yet, the province was still dependent to a great extent on the natural resources. In 1998, oil and gas accounted for approximately 65% and 92.70% of Aceh's GDP and exports respectively.

After the fall of the New Regime Order, Indonesia embarked on constitutional reform in 1999. The new government tried to reduce internal conflicts with GAM and addressed Acehnese grievances due to the inequitable distribution of resource revenue by granting a special autonomy status to Aceh (Law No.18/2001) in August 2001. According to the law, Aceh was entitled to retain about 70% of its oil and gas revenues for eight years, and it would be subject to review. Unfortunately, the Acehnese provincial assembly could not properly adopt the regulation (Ross 2005).[4]

The Aceh's economy continued to decline because of the prolonged conflict with GAM and the depletion of oil and gas reserves. The GDP of Aceh just contributed to about 2.30% of the national economy in 2003. Along with the agriculture sector, oil and gas industry remained the salience features of Aceh's economy. They were equal to 32.20% and 43% of the province GDP respectively. The sluggishness and volatility in the Aceh's economy failed to translate into lower poverty levels. Prior to the occurrence of the disaster, the Ministry for Development of Disadvantaged Regions had considered 50% districts in Aceh as least developed districts. The poverty rate was remarkably high (about 30% of the total population) in 2002.

After the tsunami, the World Bank estimated that Aceh's GDP growth in 2005 declined by 7-28 % compared to its previous year GDP, whereas the poverty level was predicted to increase to roughly 50%. The tsunami also pushes up local prices. In January 2005, the average rate of inflation in Banda Aceh, the provincial capital, climbed to 7.02%, while the national inflation was only 1.43%. Processed food and food products experienced the two highest inflation rates, corresponding to 19.26% and 11.24% respectively (Athukorala and Resosudarmo 2005; Nazara and Resosudarmo 2007).

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[4] The regulation also allows Aceh to implement Islamic law, commence Islamic courts, hold direct elections for the governor, and give extra authority to the governor to have control over the Aceh's police.

4. EMPIRICAL METHODOLOGY

We are interested in testing whether a large tsunami affects the economy of the exposed region (i.e. province). The fundamental problem we have is to find an unexposed province that best reproduces the characteristics of the exposed province. Given that none of the other comparison provinces follow the identical time trends as the province of interest; we take a weighted average of all potential comparison provinces as a control group of the exposed province. The effect of the disaster on the economy is estimated through divergence in GDP per capita between the two groups after the tsunami. This method is well-known as the synthetic control method (SCM) which was just introduced by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010). We formalise the concept of the synthetic control method as follows.

Suppose that we observe 26 provinces in Indonesia for the period $t = 1995, \dots, 2004, \dots, 2011$.[5] Let $i = 1$ be the province of Aceh, and $i = 2, \dots, 26$ be the other provinces that serve as the potential controls for Aceh. Here, we let $T_0 = 2004$ be the year when tsunami struck Aceh. We denote Y_{it}^I as GDP per capita in the presence of the tsunami, while Y_{it}^N is GDP per capita if the tsunami had not occurred. It is generally acceptable to assume that the disaster does not have any effects on the path of GDP per capita prior to its occurrence at time T_0. Hence, $Y_{it}^I = Y_{it}^N$ for $t \in [0, \dots, T_0 - 1]$. The economic effect of the tsunami for province i at time t is written as

$$\alpha_{it} = Y_{it}^I - Y_{it}^N \quad (1)$$

We also have D_{it}, the binary variable that takes a value of one if province i is exposed to the tsunami at time t and zero otherwise.

We can observe the post-tsunami outcome for province i at time t as:

$$Y_{it} = Y_{it}^N + \alpha_{it} D_{it} \quad (2)$$

In our case, the Indonesian province of Aceh is the only province that severely hit by the tsunami after T_0. Therefore,

$$D_{it} = \begin{cases} 1 & \text{if } i = 1 \text{ and } t > T_0 \\ 0 & \text{otherwise} \end{cases}$$

Our goal is to estimate α_{it} for Aceh (i =1) and for all $> T_0$, or:

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N \quad (3)$$

The above equation implies that Y_{1t}^I is observed in the period 2005-2011, whereas Y_{1t}^N is unobserved. We need to estimate Y_{1t}^N which is the counterfactual of Aceh or the synthetic control unit.

Abadie, Diamond and Hainmueller (2010) show that:

$$Y_{1t}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it} \quad (4)$$

where δ_t is an unobserved common time-dependent factor, θ_t is a vector of unobserved parameters, Z_i is a vector of observed covariates for GDP per capita that is not affected by the tsunami, λ_t is unknown common factors, μ_i is a province-specific unobservable, and ε_{it} are the error terms which represent unobserved transitory shocks at the level of province ($E(\varepsilon_{it}) = 0$ for all i and t).

For constructing the synthetic control unit, we define a (*25 x 1*) vector of weights $W = (w_2, \dots, w_{26})'$ such that $w_i \geq 0$ for $i = 2, \dots, 26$ and $\sum_{i=2}^{26} w_i = 1$. Each value of W indicates a potential synthetic control unit for Aceh. We thus state the outcome for each synthetic control as:

[5] Before the fall of the New Order Regime in 1998, Indonesia had 27 provinces. It turned to be 26 provinces after East Timor gained its independence in 1999. The remaining provinces have proliferated today, becoming 34 provinces. However, to maintain consistency, our analysis still uses 26 provinces.

$$\sum_{i=2}^{26} w_i Y_{it} = \delta_t + \theta_t \sum_{i=2}^{26} w_i Z_i + \lambda_t \sum_{i=2}^{26} w_i \mu_i + \sum_{i=2}^{26} w_i \varepsilon_{it}$$

Suppose there is a set of weights $(w_2^*, \ldots, w_{26}^*)$ that best reproduces Aceh's pre-tsunami characteristics such that:

$$\sum_{i=2}^{26} w_i^* Y_{i1} = Y_{11}, \ldots, \quad \sum_{i=2}^{26} w_i^* Y_{iT_0} = Y_{1T_0} \quad \text{and} \quad \sum_{i=2}^{26} w_i^* Z_i = Z_1$$

Abadie, Diamond and Hainmueller (2010) prove that, as long as the condition in (6) holds and the number of pre-tsunami observations is large as compared with the level of the transitory shocks, then

$$Y_{1t}^N = \sum_{i=2}^{26} w_i^* Y_{it}$$

Ultimately, the estimator for α_{1t}[6] for $t \in [T_0 + 1, \ldots, T]$ is given by

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{i=2}^{26} w_i^* Y_{it}$$

It should be noted that equation (6) can hold precisely under the condition $(Y_{11,\ldots,}Y_{1T_0,}Z_1')$ Î $\{(Y_{21,\ldots,}Y_{2T_0,}Z_2'), \ldots\ldots, (Y_{i+11,\ldots,}Y_{i+1T_0,}Z_{i+1}')\}$, implying that the observations for the treated and control units have to fall within the relevant convex hull. However, under several conditions, it is only possible to select the synthetic control that will approximately satisfy condition (6). Moreover, perhaps equation (7) will also not hold either. If this is the case, we need to examine the goodness of fit and the predictor balance for all variables in Z_1 during the pre-tsunami period.

Strictly speaking, our main task is to construct some optimal weights W^*such that both equation (6) and equation (7) hold approximately. Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010) suggest selecting W^* to minimise the differences between the pre-disaster predictors of the treated unit and a synthetic control, or:

$$\sum_{m=1}^{k} v_m (X_{1m} - X_{0m} W)^2$$

where X_1 is a (*k x 1*) vector including the observations of the pre-disaster predictors of the treated unit, X_0 is a (*k x i*) matrix consisting of the value of the same predictors for the control units, and v_m is a vector of weights on the predictors of the control units representing the significance that we assign to the *m*-th variable. The selection of v_m is fundamentally important because it determines the mean squared error of our outcomes of interest. Intuitively, the best choice is to choose v_m such that the mean squared prediction error is minimised. In other words, the set of v_m has to produce the pre-tsunami outcome that is the closest match to the synthetic and treated units.

5. ESTIMATION RESULTS

5.1 Baseline results

Recall that the synthetic control method (SCM) requires the construction of a synthetic control unit, defined as a weighted average of a linear combination of untreated units that best replicates the pre-intervention characteristics of the treated unit. Since our outcome of interest is the evolution of Aceh's GDP per capita, we need to verify whether the other Indonesian provinces can resemble Aceh very closely in terms of the predictors

[6] We use the SYNTH-NESTED command in STATA to estimate this estimator.

of GDP per capita before the onset of the tsunami.[7] Table 1 reports the mean of the main ingredients of GDP for Aceh, the synthetic unit, and the rest of Indonesian provinces.[8] The table shows that the synthetic Aceh is fairly more accurate in reproducing the pre-tsunami determinants of GDP per capita for Aceh than the rest of Indonesian provinces. We also note striking distance between the actual Aceh and its synthetic with respect to the investment rate, the shares of the primary sector and manufacturing sectors.[9] Yet the predictive power of those explanatory variables is generally weak as indicated by the small values of the predictor weight matrix, v_m .

<Insert Table 1 here>

Table 2 reports the optimal weights (W^*) of the control provinces that could potentially comprise the synthetic Aceh. Of the twenty three provinces, five provinces receive positive weights, and the remaining provinces obtain zero weights. This suggests that the synthetic Aceh is a weighted average of those five provinces, that is, Riau (0.654), DI Yogyakarta (0.128), Maluku (0.120), North Sulawesi (0.050), and Central Java (0.048). That SCM assigns the largest weight to Riau is not surprising since the economic structure of Aceh and Riau was heavily dependent on oil and gas during the sample period.

<Insert Table 2 here>

In order to obtain a clearer picture the credibility of the current application, we plot the outcome of interest for the treated unit and the synthetic provinces over the pre-treatment period in which the root mean square error (RMSPE) between the two series is minimised. Figure 1 illustrates the dynamic of GDP per capita for Aceh along with its synthetic counterpart over the years 1995-2011. The two series did not diverge far away each other until 2004. The only exception was between 2001 and 2002 when the yearly Aceh's GDP per capita exhibited a sharp fluctuation. The instability of oil and gas production due to the depletion of oil and gas reserves partly explained this trend.[10] We exclude the noisy observation in 2002 from our estimation and re-estimate our model. Again, our result in Figure 2 confirms that the economic performance of Aceh and its synthetic control tracked each other quite well prior to the tsunami. There was also a downward trend in GDP per capita of the two series during the Asian Financial crisis, and they gradually rose a few years later following the recovery period. In general, those two figures reveal the advantage of using SCM in modelling our disaster effects.[11]

<Insert Figure 1 here>
<Insert Figure 2 here>

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[7] Unlike the standard growth literature, we also account for the structural break in the economy caused by the Asian Financial Crisis and the implementation of political and fiscal decentralisation. We include lagged versions of GDP in 1996 (the final year prior to the crisis) and in 2000 (the final year before the decentralisation era).

[8] We drop the data for DKI Jakarta and East Kalimantan from the donor pool, since these two provinces deviate greatly from

[9] Because of prolonged civil conflicts, lacking access to infrastructure, and poorly functioning financial systems, Aceh had experienced a lower investment rate compared to the other provinces. The economy of Aceh, however, was relatively highly dependent on the agriculture, especially food crops and non-food crops. The oil and gas boom also accounted for a higher share of the industry in the production.

[10] It is important to note that the share of oil and gas in Aceh's GDP increased to almost double from 2001 to 2002.

[11] Since the two estimation results do not show any noticeable differences, we use our initial result to perform further analysis.

Turning to the magnitude of the disaster impact, i.e. what are the economic costs of the catastrophic event? Our estimates suggest that the tsunami has substantial negative and log-lasting effects on Aceh's GDP per capita (Figure 3). Aceh appeared to experience a decline in its GDP per capita by about 16.88% in 2005 than it would have been had the tsunami not occur (Table 3). The calculation reported here is largely consistent with the estimated by the World Bank which predicts that Aceh's GDP per capita could fall by 7% to 28 %, although we provide a particularly strong identification strategy (World Bank 2005). Moreover, the GDP per capita in Aceh is estimated to be 25.73% lower, on average, than the counterfactual in the post-disaster period.

<Insert Figure 3 here>

5.2 Placebo studies

Unlike numerous well-established statistical methods, SCM does not allow for the application of the regular tools for inference since we are making statistical inferences from a small dataset. The lack of randomisation and the use of non-probabilistic sampling also make the normal tests are not applicable. Abadie, Diamond and Hainmueller (2010) propose an alternative inference method based on placebo studies. These placebos should not respond uniformly to false interventions as the real treated unit does to the true intervention if the causal effect is unquestionable. We perform a series of placebo exercises to falsify several underlying assumptions.

5.2.1 Placebo tests among untreated units

One way to evaluate the significance of the estimated treatment effects is to falsely reassign the tsunami disaster to the other provinces that are not exposed to the event of interest. Intuitively, we consider one control unit as a treated unit as if this control province had undergone the tsunami in the treatment year. We then iteratively apply the SCM algorithm to all control provinces in the donor pool. In each experiment, we estimate the difference in outcome between a placebo unit and its synthetic control unit. In doing so, we would like to compare the economic effects of the disaster on Aceh to the distribution of estimated effects of the placebo studies. We signify the causal effect of the tsunami on Aceh's regional income per capita if the estimated effects of placebo trials lead to trivial discrepancies.

Figure 4 displays the results for this falsification test. The solid black line corresponds to the difference in GDP per capita between Aceh and its synthetic version, whereas the gray lines denote GDP per capita gaps for each control province and its relevant counterfactual. The figure clarifies that the discrepancy between GDP per capita for Aceh and its synthetic control from 2004 onwards is exceptionally large compared to the gap for any of the control provinces through which a false treatment was applied. However, Figure 4 also demonstrates that the synthetic control method fails to produces a good fit for the pre-tsunami GDP per capita for several provinces that receive an artificial treatment. To be exact, SCM is unsuccessful in finding a combination of provinces that can closely mimic GDP per capita in these provinces before 2004. If these placebo provinces cannot fit their synthetic counterpart well in the pre-tsunami period, they tend to remain to show poor matches after the tsunami period. The main concern is, however, that the statistical significance of our results derived from these tests can be misleading. Following Abadie, Diamond and Hainmueller (2010), we exclude provinces for which the synthetic control method does not do well in constructing their respective synthetic control.

Determining placebo provinces which have low goodness of fit is arbitrary. The recommended measurement to assess the goodness of fit of SCM is by making use of the root mean square prediction error (RMSPE), where the smaller the RMSPE value, the better the fit. Furthermore, Abadie, Diamond and Hainmueller (2010) suggest eliminating control units if their pre-treatment RMSPE is greater than 2 times, 5 times, or 20 times that of the RMSPE of the treated unit. By applying this threshold, we solely select provinces that show satisfactory fit as good as Aceh in the years 1995-2004. In practice, we drop four provinces with a pre-tsunami RMSPE higher than twice the pre-tsunami RMSPE for Aceh.[12] Looking at Figure 5, we can conclude that Aceh experiences the largest negative gap in GDP per capita during the post-tsunami period. Again, this picture strengthens our confidence in our baseline result.

<Insert Figure 4 here>
<Insert Figure 5 here>

5.2.2 Placebo tests in time

Another crucial issue is to check to what extent the predictive power of the synthetic control unit may derive our results. To do this, we conduct an in-time placebo test that lets the treatment occur at a different point in time. We expect the placebo effect is insignificant if in fact the true treatment results in sizeable effects. To carry out this study, we simply re-estimate our baseline model and treat the tsunami as if it had occurred in 1999, about five years earlier than the actual Indian Ocean tsunami. Figure 6 plots the results of the placebo intervention in 1999. The pattern in the figure suggests that the evolution of GDP per capita both in Aceh and in control provinces is indeed identical for the 1995-1999 periods. Needless to say, we do find negligible effects of the placebo intervention on Aceh's GDP per capita. Therefore, we interpret the result of this exercise as evidence that the substantial GDP gap for Aceh from 2005 onwards is attributable to the tsunami. A possible lack of the predictive power of the synthetic control does not exaggerate our results.

<Insert Figure 6 here>

5.2.3 Treatment extremity tests

Next, we evaluate the robustness of our findings by comparing the post and pre-treatment RMSPE ratios for the treated unit and the synthetic control unit. Indeed, a large post-treatment RMSPE does not automatically signify the estimated effects of the treatment unless the pre-treatment RMSPE is noticeably small. We compute this measure for each province in the sample and construct a probability distribution of the extremity of post-treatment outcomes for Aceh and 23 control provinces. It is apparent from Figure 7 that the ratio for Aceh is strikingly different from that of the control provinces. For Aceh, the corresponding post-tsunami RMSPE is approximately 6.27 times the pre-tsunami RMSPE. In contrast, none of control provinces demonstrate a treatment extremity since they fall within the range of 0.50 to 4.00.

If the tsunami event were randomly assigned to any province in the sample, the probability of obtaining a large and a negative effect of the disaster on GDP per capita as shown by Aceh is $1/24 \approx 0.04$ or approximately 4%. Like the usual regression analysis, if we set a p-value<0.05 rule, we reject the null hypothesis and find strong evidence that the tsunami constitutes a considerable negative shock to GDP per capita.

<Insert Figure 7 here>

5.2.4 Leave-one-out tests

[12] We also try to discard the synthetic provinces that show the average pre-tsunami RMSPE of more than five times and twenty times the RMSPE of Aceh. Yet, there still remain several lines that diverge significantly from the zero line. Hence, it is considerably difficult to disentangle the true effect of the tsunami from these placebo gaps. Full details about this case are available upon request.

Evaluating the economic impacts of natural disasters is arguably difficult if there is a post-treatment shock affecting one of the synthetic controls. This is because the indentifying assumption of the synthetic control method is that any shocks in the post-treatment period should result in a similar change in the outcome of both the treated and control units. To address such risks, we conduct a leave-one-out test with aim at testing the robustness of our results to the inclusion of any specific control unit that exposed to another unrelated shock after the occurrence of the treatment.

The estimate of the leave-one-out test is presented in Figure 8. The figure replicates Figure 1 showing GDP per capita for the actual Aceh and the baseline synthetic control. Yet we add grey lines which are constructed by iteratively excluding each province that makes up the original synthetic Aceh. According to this graph, omitting each province that receives a positive weight in the previous section still brings each of the leave-one-out synthetics closer to the baseline synthetic Aceh. This indicates that our results are not driven by any specific province.

<Insert Figure 8 here>

5.3 Discussion

A strand of canonical literature assessing the economic costs of natural disasters has come to agreement on significant impacts of such events on the macro-economy. The general consensus is that the response of the economy to disaster shocks unquestionably depends on a country's level of economic and institutional development, in which developing countries tend to be more vulnerable to macroeconomic consequences of natural disasters.

Using Indonesian provincial data and employing a novel counterfactual approach, we provide new evidence that the tsunami catastrophic disaster in 2004 has substantial adverse effects on the economy of the exposed region. This finding seems to contradict the Schumpeterian creative destruction hypothesis. Nevertheless, we reach the same conclusion as ***duPont*** and Noy (forthcoming) which assemble Japanese prefecture data. Intriguingly, our article corroborates that of the study based on developed country data which uses the identical identification strategy, but we are able to come to one important aspect: the degree of the disaster costs. While ***duPont*** and Noy predict the medium-term effect of the earthquake on Kobe's GDP per capita is about 9%, we estimate that the 2004 Indian tsunami produces far greater economic losses to Aceh. Our estimated intermediate effect for the tsunami disaster on Aceh's GDP per capita is around 25.73%.

The striking difference in the estimates for the advanced economy and the third world is not puzzling. We have at least two possible arguments to support this. First, as pointed out by Noy and Nualsri (2011), this is partially explained by the dissimilarity of the fiscal dynamics in both developed and developing countries in the aftermath of natural catastrophes. Developed countries generally show counter-cyclical behaviours of fiscal policy in the aftermath of natural disasters. On the other hand, developing countries tend to adopt pro-cyclical fiscal policies following disaster shocks. Nevertheless, the pro-cyclical fiscal behaviours in which governments largely reduce expenditures and raise revenues as an immediate response to large disaster events can impede the acceleration of economic recovery. This is also relevant in our context. It was reported that Aceh's fiscal ledger grew stronger because of receiving an unprecedented amount of aid and assistance from the central government and the international community for rehabilitation and reconstruction after the December 2004 tsunami.

Second, the difference in the economic structure to some extent is also imperative. Although the Aceh's economy is marked by a high degree of dualism, the tsunami seriously hurt the agricultural sector that is strongly linked with the rest of the economy. Given strong forward and backward linkages between the agricultural sector and the other economic sectors, these imply that the tsunami shock to the primary sector will also be transmitted to different sectors of the economy. In other worlds, the tsunami catastrophe affects a wide range of economic sectors, and its magnitude is non-trivial.

While the findings from this current study shed new light on the economic costs of large natural disasters in the context of developing countries, we should interpret these results with some caveats to keep in mind since we cannot completely rule out the potential confounding effects of the Aceh conflict which coincided with the tsunami. Although we outlined earlier that there were a series of peace negotiations between the government of Indonesia and GAM prior to the outbreak of the tsunami, the peace process collapsed in 2003 because GAM accused the Indonesian military of launching a large-scale military operation in Aceh. Thus, our estimated average outcome is somewhat upward bias of the true effect of the tsunami disaster.

6. CONCLUSION

We investigate the effects of the economic exposure to a catastrophic disaster in the Aceh province of Indonesia following the Indian Ocean tsunami at the end of 2004. Although the national economy seems less affected by the event, the regional income per capita of the exposed province experiences a significant construction. It was estimated that total damages and losses from this catastrophe amount to 97.40% of Aceh's GDP in 2003. According to international experience, the affected economy will encounter serious difficulties in returning the economy to its pre-disaster level if the ratio of the disaster impact to GDP goes beyond 40%. In line with these reports, we find that the aggregate loss entailed by the onset of the tsunami is equivalent with a sizeable reduction of GDP per capita, and it tends to be persistent.

To the best of our knowledge, this is the first study applying a-quasi-experimental strategy and focusing exclusively on single developing country data to identify the causal effects of large natural disasters on the short- and the medium-term of income per capita. Importantly, this method allows us to control for endogeneity between economic variables and natural disasters (e.g. faster economic growth may raise the probability of natural disasters). Another critical point is that the utilisation of SCM offers a great advantage of selecting comparison units based on a more transparent data-driven procedure to avoid the risk of drawing inference from parametric extrapolation. From the theoretical perspective, we also implicitly take into account the heterogeneity of natural disasters effects which is often disregarded in previous studies. The econometric results provide compelling evidence on the effects of disaster shocks on economic conditions.

One major limitation of the macroeconomic framework as our current work is that it does not give a detailed explanation of the total welfare loss from disaster incidents. The study of microeconomic data apparently helps to indentify utility losses together with many other multifaceted dimensions (such as education, health, and poverty). This analysis is especially suitable for a country like Indonesia because the consequences of large disasters are more serious, but there is no adequate insurance coverage to protect households from such extreme events. For this reason, an investigation of the distributional impacts as well as insurance mechanisms against the economic costs of natural disasters deserves further attention in the future research.

At last, the Aceh province of Indonesia offers a unique experience to better understand the economic consequences of large natural disaster occurrence. Whether our unintended outcome for Indonesia is also true for other developing countries, particularly the other worst-affected countries – Sri Lanka, India, and Thailand, are still an open question.

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Lampiran E2. Naskah untuk Publikasi di International Conference on Statistics and Mathematics (akan dimuat di International Journal of Applied Mathematics and Statistics)

2014 International Conference on Statistics and Mathematics (ICSM 2014)

Examining Spatial Effects of Regional Income Convergence in Sumatra Island

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Abstract

Spatial income disparities have become a central discussion in regional development. This study aims at addressing these issues by examining spatial effects of regional income convergence in Sumatra Island. We also take into account the possible role of the tsunami disaster of 2004 in shaping growth trajectories among provinces in Sumatra. Our results do suggest a persistence income convergence in the island regardless of the onset of the tsunami. The spatial effects indicate a nontrivial spillover effect of the Aceh's economy on the other provinces only during the pre-disaster period.

Keywords: spatial effects; regional income convergence; tsunami.

1. Introduction

Receding regional income disparity has become a major challenge for the long-term national development agenda. Spatial income inequalities among islands and provinces are the special features of this fact. To date, few studies have been devoted to test convergence and divergence of regional income in Indonesia. The most recent study suggests the presence of convergence in per capita gross regional domestic product (GRDP) during the period 2005-2008. It also highlights the important role of neighborhood effects on convergence processes [1].

In this article, we reinvestigate the income convergence hypothesis across Indonesian provinces. This paper differs from [1] in several important aspects. First, we focus on the convergence process amongprovinces in Sumatra. The spatial analysis of regional income in Sumatra is an interesting case study because this island has experienced a persistent inter-provincial income inequality as a result of the uneven geographical distribution of natural resources, especially oil and gas. Second, Sumatra which is located in the western part of the Ring of Fire is very susceptible to natural disasters. A notable example is the Indian Ocean tsunami in 2004. It was reported that the disaster caused

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sizeable economic damages and losses, accounting for approximately 97.4% of Aceh's GRDP in 2003 [2-3]. Hence, we also address the question whether the catastrophic tsunami disaster has a substantial influence on the speed of income convergence among Sumatra regions. Third, we employ the hierarchical modeling for univariate spatial data [4-5] allowing for parameter heterogeneity in regional income regressions and spatial economic spillovers among neighboring provinces in Sumatra. From the economic literature, the former contributes to debate on the validity of the traditional Solow growth model [6], whereas the latter points to the advantage of core regions instead of peripheral regions in terms of the rate of growth convergence [7].

The remainder of the paper proceeds in the following way. Section 2 introduces modeling regional income with spatially varying coefficients and gives a brief overview of the data. Section 3 presents and discusses the main findings. The final section summarizes and concludes.

2. Methods and Data

We model the economic growth rate (Y) to follow a univariate Gaussian stationary spatial process as [8]:

$$Y(\boldsymbol{s}) = \mu(\boldsymbol{s}) + W(\boldsymbol{s}) + \varepsilon(\boldsymbol{s}) \quad (1)$$

where $\mu(\boldsymbol{s}) = \mathbf{x}(\boldsymbol{s})^T\beta$ and $\varepsilon(\boldsymbol{s})$ is a white noise process, i.e., $E(\varepsilon(\boldsymbol{s})) = 0$, $\text{var}(\varepsilon(\boldsymbol{s})) = \tau^2$, $\text{cov}(\varepsilon(\boldsymbol{s}), \varepsilon(\boldsymbol{s}'))=0$, and $W(\boldsymbol{s})$ is the spatial random effects. $E(W(\boldsymbol{s})) = 0$, $\text{var}(W(\boldsymbol{s})) = \sigma^2$, $\text{cov}(W(\boldsymbol{s}), W(\boldsymbol{s}')) = \sigma^2\rho(\boldsymbol{s}, \boldsymbol{s}'; \phi)$, where ρ is a valid two-dimensional correlation function.

Let $\mu(\boldsymbol{s}) = \beta_0 + \beta_1\mathbf{x}(\boldsymbol{s})$, write $W(\boldsymbol{s}) = \beta_0(\boldsymbol{s})$ and define $\tilde{\beta}_0 = \beta_0 + \beta_0(\boldsymbol{s})$. Then $\beta_0(\boldsymbol{s})$ can be interpreted as a random spatial adjustment at location $\boldsymbol{s}$to the overall intercept $\beta_0$and $\tilde{\beta}_0$ can be interpreted as a random intercept process [4]. The distribution of $\boldsymbol{\beta}_0 = (\beta_0(s_1), \ldots, \beta_0(s_n))^T$ is

2.1

$$f(\boldsymbol{\beta}_0 | \sigma_0^2, \phi_0) = N(\mathbf{0}, \sigma_0^2 H_0(\phi_0)) \quad (2)$$

where$(H_0(\phi_0))_{ij} = \rho_0(s_i - s_j; \phi_0)$, here $\rho(\boldsymbol{h}, \phi)$ is the Matern correlation function.

To estimate the above model, we use the R package for the hierarchical modeling for univariate spatial [5].

2.2. Data

We study the regional income convergence for the period 2003-2008 utilizing provincial data sets for all provinces of Sumatra from the Indonesian Central Bureau of Statistics (BPS). To maintain long-term comparability, we merge Kepulauan Riau and Bangka Belitung, the new separated provinces, with their original provinces, Riau and South Sumatera respectively, and this leaves us with 8 provinces. The details of the geographical position of Sumatra Island along with its map are given in Appendix A.

Our main data are the GRDP of provinces in Indonesia by industrial origin and expenditure category at the 2000 constant prices, and the National Social Economic Survey (SUSENAS). The outcome variable is the growth in per capita GRDP which is calculated as the annual growth rate of GRDP by economic sector. The explanatory variables are divided into two thematic groups as follows.

1. The measures of convergence, factor accumulation, stabilization policies: initial GRDP per capita (1995, in logs), share of capital in GRDP, and share of government expenditure in GRDP.
2. Human capital: literacy rate of people aged 15 and above.

3. Results and Discussion

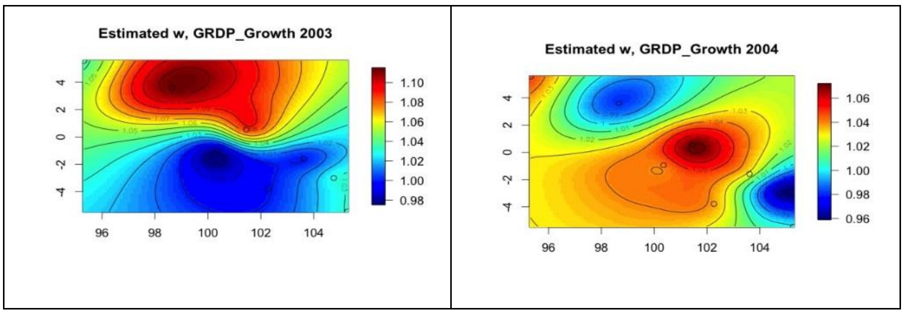
Table 1 presents our main findings. We begin our analysis by discussing the evidence of regional income convergence during 2003-2008. Theoretically, there are two concepts of income convergence which are related each other: sigma convergence and beta convergence. Sigma convergence ($\boldsymbol{\sigma}$ −convergence) occurs when the dispersion of per capita income across provinces declines over time. The second notion is beta convergence ($\boldsymbol{\beta}$ −convergence) which is used in this paper. It suggests that provinces with higher initial income levels grow slowly than provinces with lower income levels or referring to the catching-up effect. At the empirical level, $\boldsymbol{\beta}$ −convergence holds when the relationship between growth in income and its initial level is negative. The results do show the present of $\boldsymbol{\beta}$ −convergence among provinces in Sumatra Island. However, the estimated coefficients vary significantly during the study period, ranging from 0.90% to 14.9% per year. This large variation is probably due to the use mining GRDP instead of non-mining GRDP, while the production of oil and gas continues to fluctuate throughout the year.

The table also reveals that the tsunami disaster does not change our finding. The estimated for the initial income is still negative and reasonably stable at around 7% in the year following the 2004 tsunami. Although the event caused widespread disruptions for the economy with the economy of Aceh was remarkably affected [9], it could recovered quickly as the rehabilitation and reconstruction of basic socioeconomic infrastructure went well. Moreover, the pattern of the convergence seems to demonstrate the Solow-Swan neo-classical model which predicts temporarily growth in the aftermath of natural disasters.

Table 1. The estimated parameters for growth determinants, 2003-2008

Parameter	2003	2004	2005	2006	2007	2008
Intercept	0.871	-0.304	-1.400	1.610	-0.885	3.160
Initial income	-0.149	-0.073	-0.071	-0.009	-0.077	-0.086
Share of government	-1.020	-0.315	-0.166	-0.324	-0.325	-0.435
Share of capital	-0.192	0.126	-0.095	0.038	0.139	0.556
Literacy rate	0.302	0.860	2.010	-1.590	1.500	-2.710
ϕ	18.500	15.500	16.400	14.700	16.600	14.500
σ^2	0.238	0.365	0.254	0.219	0.224	0.250
τ^2	0.256	0.240	0.243	0.234	0.265	0.280

The final exercise is to assess whether the neighborhood effect or the spatial effect determines regional income growth of Sumatra. Specifically, we are interested in understanding the role of the Aceh's economy on the economic performance of its neighboring provinces after experiencing the tsunami of December 2004. The spatial effect of economic growth among provinces in Sumatra is illustrated in Figure 1. The figure clearly documents a strong spatial effect of income growth in Aceh before the tsunami and this effect is rather weak in the post tsunami period. We interpret this finding as the trivial economic spillovers from Aceh to the rest of Sumatra's provinces in the aftermath of the catastrophic disaster.



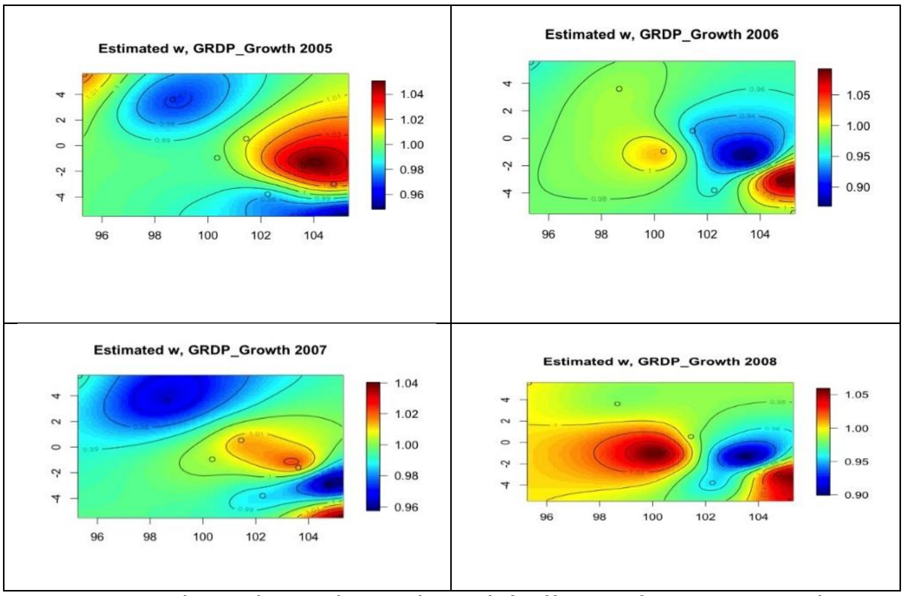


Fig 1.The estimated spatial effects of GRDP growth, 2003-2008

4. Conclusion

This paper has attempted to test the income convergence hypothesis and identify the spatial economic effect among provinces in Sumatra. We also give emphasis to the role of the tsunami in 2004 in shaping economic growth of Sumatra Island. The results demonstrate the existence of $\beta -$convergence and this continue to hold during the post-tsunami period. The inclusion of the spatial effects in our model confirms that a significant spillover effect of the Aceh's economy on the other provinces only pertains to the sample before the disaster.

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Appendix A. The geographical position of Sumatra Island and its map

Table A. The geographical position of Sumatra Island

Province	Capital City	Longitute	Latitude
Aceh	Banda Aceh	95.317	5.550
North Sumatera	Medan	98.669	3.592
West Sumatera	Padang	100.353	-0.950
Riau	Pekanbaru	101.447	0.534
Jambi	Jambi	103.610	-1.590
South Sumatera	Palembang	104.757	-2.990
Bengkulu	Bengkulu	102.262	-3.792
Lampung	Bandar Lampung	105.265	-5.448

Fig A. The map of Sumatra Island

Lampiran E3. Naskah untuk Publikasi di The 5th International Conferences on Aceh and Indian Ocean Studies, Banda Aceh, 17-18 November 2014

Assessing the Impact of the Indian Ocean Tsunami on the Economy: Evidence from Indonesia and Thailand

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Abstract— Recent research in developed countries shows an adverse effect of natural disasters on the economy. This paper aims at examining whether this is also relevant for developing countries. Applying a counterfactual approach to provincial data for Indonesia and Thailand, we find that the Indian Ocean tsunami of 2004 negatively affects per capita gross domestic product (GDP) of the exposed provinces. It is also shown that the effect is heterogeneous within the country. These results seem straightforward to reconcile with previous evidence using developed countries data.

Keywords—natural disaster, economic impact, developing country.

INTRODUCTION

A SMALL but growing literature has been devoted to study the economic consequences of disasters with the evolution of gross domestic product (GDP) as the central topic. The other common characteristic is the level of analysis focusing on cross-country studies. Intriguingly, existing empirical studies produce mixed-results. Following neoclassical growth frameworks, natural disasters are predicted to have a positive effect on the GDP trajectory. In contrast, endogenous growth models provide less clear-cut explanation of disaster effects. A class of endogenous growth models à la the Schumpeterian creative destruction process reaches an agreement with the neoclassical theory. Several earlier works seem to support favorable effects of natural disasters [1]-[3]. Yet, the AK-type endogenous growth models predict trivial impacts of disasters on the growth rate even though the economy that experiences a destruction of the capital stock will never go back to its pre-disaster growth path. Another variant of the endogenous growth theory with a production function that exhibits increasing returns to scale

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posits that natural disasters lead to adverse and permanent effects on growth trajectories [4]-[5].

However, conducting cross-country studies to evaluate the actual impact of natural hazards gives rise to two main problems. First, from growth theory, this means that they impose the strong assumption of parameter homogeneity [6]. Therefore, the effects of population growth, physical and human capital, as well as the initial level of income on income growth are the same for all countries in the analysis. In fact, this assumption is very strong and unrealistic. For instance, it is very unlikely that different types of natural disasters produce similar effect on the economy. Second, country-level studies unable to capture the spatial distributional effect of the disaster.

This paper seeks to fill the gap by investigating the causal effect of the tsunami catastrophic disaster in 2004 on the regional economy of Indonesia and Thailand, the two most affected countries. It was 26 December 2004 at 00.59 GMT (just before 08.00 a.m. Jakarta time), when a powerful earthquake with magnitude of 9.0 on the Richter scale hit Sumatra Island of western Indonesia. The earthquake subsequently generated devastating tsunami waves, yielding the tallest wave as high as 24.4 meters. The tsunami totally slammed Aceh Province of Sumatra, the closest area to the epicenter of the earthquake, whereas Nias Island of North Sumatra Province was less affected. The successive tsunami moved to the west to hit coastal areas of the other Asia countries (India, Malaysia, Maldives, Myanmar Srilanka, and Thailand) and several African countries (Kenya, Somalia, and Tanzania). In Thailand, the impacts of the tsunami were more pronounced in the southern part, especially Phuket, Krabi, Phang Nga, Trang, Ranong, and Satun [7].

Looking at the data, it was reported that Indonesia experienced by far the highest number of fatalities than Thailand (over 165,000 versus 8,300) representing about 70% of all deaths. Although these countries suffered from the misery, the macroeconomic impact on Indonesia and Thailand in 2005 was predicted to be small because Aceh's GDP was approximately 4% of Indonesian GDP whereas the combined six provinces of Thailand accounted for only 2.7% of the national GDP (The Economist Intelligence Unit, 2005). Yet, preliminary findings reported that the tsunami had a sizeable impact on the regional economy of Aceh in Indonesia and Phuket and Krabi in Thailand [8]-[9].

We use the synthetic control method (SCM) to estimate our causal of interest [10]-[11]. SCM is an extension of the original difference-in-differences (DiD) but it is less stringent with respect to the identical trend assumption and it allows for the presence of unobservable time-variant provinces characteristics. The method is suitable in our case since the tsunami is considered as a large shock influencing a single province.

This current work enriches fairly limited study available on the economics of natural disasters in developing countries. The findings of our work also complement a recent study based on developed country data [12] and corroborate disaster theories about a non-linear relationship between a country's income per capita disaster shocks.

This paper proceeds as follows. In Section 2, we give an overview of estimating the distributional effect of the tsunami by utilizing SCM. Section 3 presents the main findings of the paper. The last section concludes.

Synthetic Control Methods

We are interested in examining whether the Asian tsunami has a substantial influence on the provincial GDP per capita of Indonesia (i.e. Aceh and North Sumatra) and Thailand (i.e. Phuket, Krabi, Phang Nga, Trang, Ranong, and Satun). The fundamental problem we have is to find an unexposed province that best reproduces the characteristics of those exposed provinces. Given that none of the other comparison provinces follow the identical time trends as the provinces of interest; our strategy is to take a weighted average of all potential comparison provinces as a control group of the affected provinces. Therefore, the economic effect of the disaster is estimated through the difference in the regional GDP per capita between the two groups after the tsunami. This method is well-known as the synthetic control method (SCM). We formalize the concept of the synthetic control method as follows.

Suppose that we observe *n* provinces (*n* =24 provinces for Indonesia[14] and *n* =35 provinces for Thailand[15]) for the period *t* =1995,…,2004,…,2012. Let *i* =1 be the exposed province, and *i* =2,…, *n* be the other provinces that serve as the potential control group or the donor pool for the affected province. Here, we let T_0 =2004 be the year when the tsunami struck Indonesia and Thailand. We denote Y_{it}^I as the regional GDP per capita in the presence of the tsunami, while Y_{it}^N is the regional GDP per capita if the tsunami had not occurred. It is generally acceptable to assume that the disaster does not have any effects on the outcome prior to its occurrence at time T_0. Hence, $Y_{it}^I = Y_{it}^N$ for $t \in [0,\ldots, T_0 -1]$. The economic effect of the tsunami for province *i* at time *t* is written as:

$$\alpha_{it} = Y_{it}^I - Y_{it}^N \quad (1)$$

We also have D_{it}, the binary variable that takes a value of one if province *i* is exposed to the tsunami at time *t* and zero otherwise.

We can observe the post-tsunami outcome for province *i* at time *t* as:

$$Y_{it} = Y_{it}^N + \alpha_{it} D_{it} \quad (2)$$

For each model, we assume that the only first province in Indonesia and Thailand hit by the tsunami after T_0. Therefore,

$$D_{it} = \begin{cases} 1 & if\ i = 1\ and\ t > T_0 \\ 0 & otherwise \end{cases}$$

Our goal is to estimate α_{it} for the eight affected provinces (*i* =1) and for all $t > T_0$, or:

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N \quad (3)$$

The above equation implies that Y_{1t}^I is observed in the period 2005-2012, whereas Y_{1t}^N is unobserved. We need to estimate Y_{1t}^N which is the counterfactual of the exposed provinces or the synthetic control units.

It is shown in [12] that:

$$Y_{It}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it} \quad (4)$$

where δ_t is an unobserved common time-dependent factor, θ_t is a vector of unobserved parameters, Z_i is a vector of observed covariates for important ingredients for a growing GDP that is not affected by the tsunami, λ_t is unknown common factors, μ_i is a province-specific unobservable, and ε_{it} are the error terms which represent unobserved transitory

[14] Since the introduction of the Regional Autonomy Law in 1999, the number of provinces has been proliferating in Indonesia. Maluku and Papua have split into two provinces since 1999. The new provinces are North Maluku and West Papua. A year later, the other three provinces were established, i.e. Bangka Belitung of South Sumatra, Banten of West Java, and Gorontalo of North Sulawesi. Riau and South Sulawesi were separated to Kepulauan Riau in 2002 and West Sulawesi in 2004 respectively. The latest was North Kalimantan which was previously the part of East Kalimantan before 2012. Overall, there were 34 provinces in 2012. To maintain consistency, we amalgamate these proliferated provinces with their original provinces and leave us with 26 provinces. However, we exclude DKI Jakarta and East Kalimantan from the donor pool since these two provinces have extremely high per capita GDP among the other provinces.

[15] Thailand has 76 provinces and is geographically divided to seven regions, i.e. Bangkok and Vicinities (6 provinces), Northern (17 provinces), North eastern (19 provinces), Southern (14 provinces), Eastern (8 provinces), Western (6 provinces), and Central (6 provinces). We only use the four last regions in the analysis due to their similar socioeconomic characteristics.

shocks at the level of province ($E(\varepsilon_{it}) = 0$ for all *i* and *t*).

For constructing the synthetic control unit, we define a (*rx1*) vector of weights $W = (w_2,....w_n)'$ such that $w_i \geq 0$ for *i* =2,…, *n* and $\sum_{i=2}^{n} w_i = 1$. Each value of W indicates a potential synthetic control unit for each exposed provinces. We thus state the outcome for each synthetic control as:

$$\sum_{i=2}^{n} w_i Y_{it} = \delta_t + \theta_t \sum_{i=2}^{n} w_i Z_i + \lambda_t \sum_{i=2}^{n} w_i \mu_i + \sum_{i=2}^{n} w_i \varepsilon_{it} \quad (5)$$

We need to choose a set of weights $(w_2^*,....,w_n^*)'$ that best reproduces pre-tsunami characteristics of the exposed provinces such that:

$$\sum_{i=2}^{n} w_i^* Y_{i1} = Y_{11},..., \sum_{i=2}^{n} w_i^* Y_{iT_0} = Y_{1T_0} \text{ and } \sum_{i=2}^{n} w_i^* Z_i = Z_1 \quad (6)$$

It is proved that, as long as the condition in (6) holds and the number of pre-tsunami observations is large as compared with the level of the transitory shocks [11], then

$$Y_{1t}^N = \sum_{i=2}^{n} w_i^* Y_{it} \quad (7)$$

Ultimately, the estimator for α_{1t} for *t*∈[T_0 +1,…,T] is given by

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{i=2}^{n} w_i^* Y_{it} \quad (8)$$

It should be noted that equation (2) can hold precisely under the condition $(Y_{11},...,Y_{1T_0,} Z_1')\hat{I}\{(Y_{21},...,Y_{2T_0}, Z_2'),.....,(Y_{i+11},.....,Y_{i+1T_0}, Z_{i+1}')\}$ However, in some cases, it is often possible to select the synthetic control W^* to approximately satisfy condition (6).

To assess the validity of our causal results, we conduct a series of placebo tests aimed at testing the underlying identification assumptions of our models. However, our falsification tests must depend on permutation inference since the small samples used in SCM.

RESULTS AND DISCUSSION

The essence of SCM is to construct a counterfactual unit or a synthetic control unit that closely replicates the pre-tsunami characteristics of the affected provinces. This is defined as a weighted average of unexposed provinces whose per capita GDP is akin to the affected provinces if it had not been hit by the tsunami. Figure 1 shows that the levels and trends of per capita GDP between the exposed province and the synthetic control unit in all eight cases are very similar.[16] The values of per GDP ingredients of the exposed provinces before the onset of the tsunami do not diverge significantly to those of the synthetic units.[17] These findings suggest that the current exercises satisfy the identifying assumptions of SCM. The exposed and synthetic provinces are fairly comparable after the tsunami period.

What about the economic impacts of the tsunami? Figure 1 clearly shows that the tsunami has a negative effect on per capita GDP in Aceh, Phuket, Krabi, Phang Nga, and Satun, whereas it turns to be small and positive in North Sumatra, Trang, and Ranong. However, it is should be noted that between Aceh and Phuket, the two most affected provinces, the evolution of per capita GDP is remarkably different. Aceh appears to experience a persistent decline in its GDP per capita while Phuket is able to recover from the catastrophic disaster and moves toward an upward trend.

Table 1 presents summary statistics of the per capita GDP gaps between the affected

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[16] We use a different length of the pre-tsunami period to minimize the root mean squared prediction error (RMSPE) for each case because per capita GDP of some province fluctuated in the late 1990s.

[17] The predictor balance tests available upon request.

provinces and the synthetic units. Given the level of Aceh's actual GDP per capita, per capita GDP in this province seems to be 16.24% lower than in the synthetic counterfactual in 2005 and -27.02% on average during the period from the occurrence of the tsunami. Looking at Phuket, per capita GDP is 21.95% lower in 2005 and 3.08% lower on average. In general, the table also suggests that the economic effect of the tsunami is larger in Indonesia than Thailand (reducing per capita GDP by 7.31% and 4.98% in 2005 respectively).

To test the validity of our results, we perform a four different type of placebo exercises (i.e. placebo tests among untreated unit, placebo tests in time, treatment extremity test, and leave-one-out tests) to falsify several underlying assumptions. These placebos should not respond uniformly to false interventions as the real treated unit does to the true intervention if the causal effect is unquestionable. These falsification tests further strengthen our findings.[18]

TABLE I

SUMMARY OF THE TSUNAMI IMPACT IN INDONESIA AND THAILAND

	2005		Average	
	Gap	%	Gap	%
Indonesia	-816.21	-7.31	-1,245.45	-10.36
Aceh	-1,744.82	-16.24	-3,014.25	-27.02
North Sumatra	112.40	1.62	523.36	6.30
Thailand	-9,285.87	-4.98	-1,534.04	-1.17
Phuket	-49,445.71	-21.95	-6,757.41	-3.08
Krabi	-8,863.03	-11.31	-446.27	-0.63
Phang Nga	-732.29	-0.91	4,797.00	5.30
Trang	988.23	1.52	-4,773.15	-6.48
Ranong	2,392.44	2.86	-921.82	-0.80
Satun	-54.84	-0.08	-1,102.58	-1.34

Notes: Gap is the difference in per capita GRDP between the exposed province and the synthetic control unit (in 1,000 Rupiah for Indonesia and in Baht for Thailand). % is the ratio of Gap to per capita GRDP of the synthetic control. Average is averaged over the post-tsunami period.

Conclusion

We investigate the effects of the regional economic exposure to a catastrophic disaster in Indonesia and Thailand in the aftermath of the 2004 Indian Ocean tsunami. We find that Aceh, Phuket, Krabi, and Phang Nga experience a nontrivial decline in their per capita GDP, whereas the economy of North Sumatra, Trang, Ranong and Satun are less affected.

To the best of our knowledge, this is the first study applying a-quasi-experimental strategy and focusing exclusively on macroeconomic data from developing countries to identify the causal effects of a large natural disaster on the short- and the medium-term of income per capita. However, a major limitation of the macroeconomic framework as our current work is that it does not give a detailed explanation of the total welfare loss from the disaster. The study of microeconomic data apparently helps to identify utility losses together with many other multifaceted dimensions (such as education, health, and poverty). This analysis is especially suitable for developing countries, like Indonesia and

[18] Results available upon request.

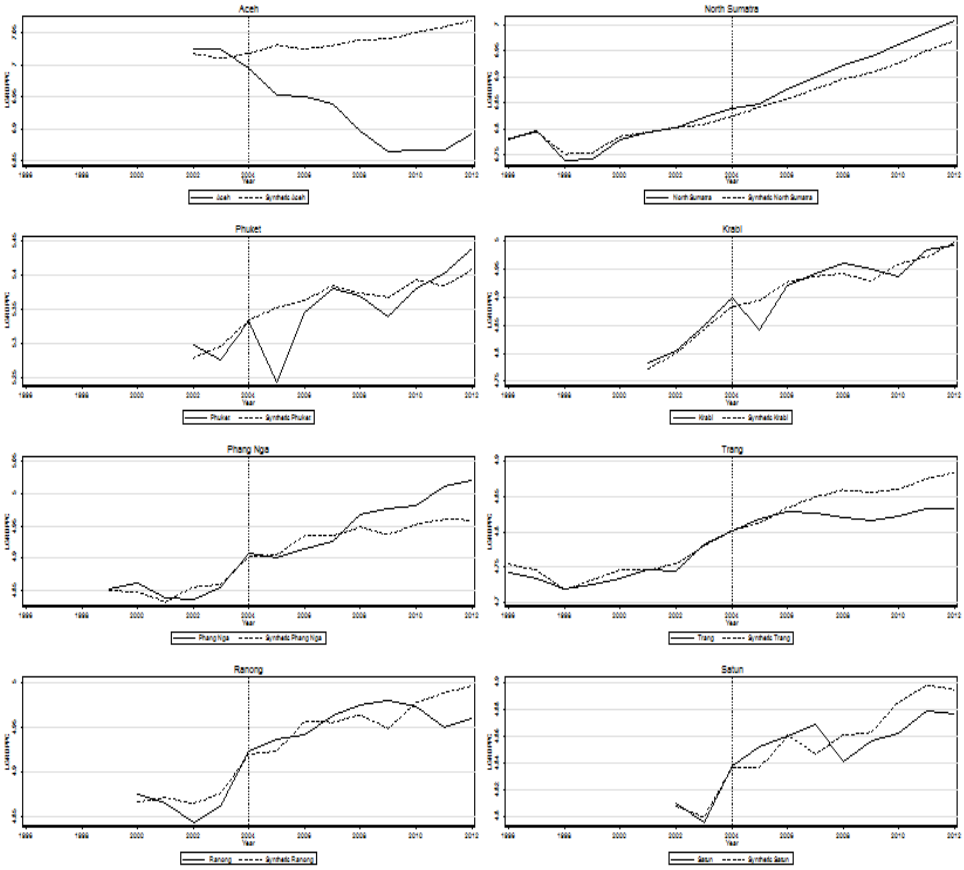

Fig. 1 Per capita regional GDP (in log): affected provinces and synthetic control units

Thailand because the consequences of large disasters are more serious, but there is no adequate insurance coverage to protect households from such extreme events. For this reason, an investigation of the distributional impacts as well as insurance mechanisms against the economic costs of natural disasters deserves further attention in the future research.

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APPENDIX A: DATA DESCRIPTION

We describe the data used in the analysis and provide sources. The data are at the provincial level for the period 1995-2012.

Indonesia:

Per capita regional GDP (millions of Rupiah). Source: Central Bureau of Statistics (BPS). The data are obtained by dividing the value of GDP in a particular province by its total population.

Sectoral shares (%). Source: Central Bureau of Statistics (BPS). It consists of the value added of 9 economic sector, that is, agriculture, hunting, forestry, and fishing, mining and quarrying, manufacturing, electricity, gas, and water, construction, trade, hotel, and restaurant, transportation and telecommunication, finance, real estate, and services. The share of each sector is obtained by dividing the value added of each sector by the total provincial GDP.

Population density (persons per square kilometer). Source: Central Bureau of Statistics (BPS). It is calculated as total population divided by land area in kilometre square.

Human capital (%).Source: Central Bureau of Statistics (BPS). It includes educational attainment of the population (i.e. adult literacy rates, primary school, junior high school, senior high school, and university).

Physical capital (%).Source: Central Bureau of Statistics (BPS). It is the share of fixed capital formation in the provincial GDP.

Thailand:

Per capita regional GDP (millions of Bath). Source: National Statistical Office of Thailand (NSO). The data are obtained by dividing the value of GDP in a particular province by its total population.

Sectoral shares (%).Source: National Statistical Office of Thailand (NSO). It consists of the value added of 16 economic sector, that is, agriculture, mining and quarrying, manufacturing, electricity, gas and water supply, construction, wholesale and retail trade, hotels and restaurants, transport, storage and communications, financial intermediation, real estate, renting and business activities, public administration and defence; compulsory social security, education, health and social work, other community, social and personal service activities, and private households with employed persons

Population density (persons per square kilometer). Source: Ministry of Interior. It is calculated as total population divided by land area in kilometre square.

Human capital (%).Source: National Statistical Office of Thailand (NSO). It includes educational attainment of the population (i.e. preschool, primary school, junior high school, senior high school, and university).