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TAHUN KE

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(NIDN.0706026501)

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:Evaluasi Dampak Bencana Tsunami 2004 terhadap Kinerja Perekonomian Provinsi Aceh: Aplikasi Synthetic Control Methods 13

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Mengetahui,

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Dr. Siana Halim, S.Si.,M.Sc.nat 92

NIP. 94-032/ NIDN. 0709117091 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 i PRAKATA Ucapan syukur dan terima kasih, kami

panjatkan kepada Tuhan Yesus Kristus, yang telah memberikan 121
kesempatan **dan** perkenanaan **sehingga**

Penelitian Hibah Bersaing dengan Judul: **Evaluasi Dampak Bencana Tsunami 2004 terhadap Kinerja Perekonomian Provinsi Aceh: Aplikasi Synthetic Control Methods** 39

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 38

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 ii DAFTAR ISI

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BAB 1 PENDAHULUAN 1.1. Latar Belakang Seiring dengan **152**

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,** **100**

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

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

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

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 berkem- bang, 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.

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 VÃ¶ gh (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). TAHUN II TAHUN I Metode Analisa dan Pengujian Bias Studi literatur Penentuan Desain Penelitian synthetic control Tahap 7 Penyusunan dampak ekonomi Laporan Awal Penelitian methods Tahap 8 bencana tsunami: Tahap 2 placebo tests Ta1h1ap ? Produk Domestik Natural Penyusunan Bab I-Bab III Penyusunan Bruto Experiment ? Pertumbuhan Laporan Akhir Penelitian Tahap 5 Ekonomi Luaran Peneltian ? Pengangguran ? Konferensi ? ? ? Seminar Kebijakan Publik: Kesempatan Kerja Penentuan Sampel Rekapitulasi dan ? Jurnal Ilmiah Kemiskinan Penelitian Coding Tahap 6 Konferensi Bappeda Aceh ? Ketidakmerataan distribusi Cleaning data Diseminasi Tahap 10 pendapatan baseline dan follow-up Exploratory Data Tahap 9 ? Sektor Fiskal Analysis ? Pengumpulan Data Tahap 3 Partisipasi Sekolah Statistik Deskriptif Penyusunan Bab IV-Bab V Tahap 1 Data dan Sampel Tahap 4 Gambar 2. Diagram alir penelitian

10 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** **88**

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** **126**

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)** **38**

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 internasio- nal. Masukan-masukan yang diterima selama konferensi diharapkan dapat menyem- purnakan 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 ð‘Œð‘–ð‘¡ adalah variabel-variabel makroekonomi (selanjutnya disebut sebagai outcome) yang harus dievaluasi akibat bencana tsunami untuk Provinsi ð‘– (ð‘– = 1 untuk Provinsi Aceh, dan ð‘– > 1 untuk Provinsi-provinsi lain) dan waktu ð‘¡ (untuk periode waktu ð‘¡ = 1, â€¦ ð‘‡0, â€¦ , ð‘‡; dimana ð‘‡0 adalah waktu terjadinya tsunami), sedangkan ð‘Œð‘–ð¼ð‘¡ adalah outcome dari terjadinya tsunami dan ð‘Œð‘–ð‘¡ 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 ð‘¡0(ð‘Œð‘–ð¼ð‘¡ð‘Œð‘–ð‘¡ < ð‘‡0). Jika besaran-besaran makroekonomi yang dapat diobservasi dapat dinyatakan sebagai ð‘Œð‘–ð‘¡ = ð‘Œð‘–ð‘¡ + ð›¼ð‘–ð·ð‘–ð‘¡, dimana ð›¼ð‘–ð‘¡ adalah dampak bencana tsunami terhadap variabel- variabel tersebut (ð‘Œð‘–ð¼ð‘¡ â^' ð‘Œð‘–ð‘¡) dan ð·ð‘–ð‘¡ merupakan indikator binary yang menunjukkan kejadian bencana tsunami (ð·ð‘–ð‘¡ = 1 untuk ð‘¡ â‰¥ ð‘‡0 dan ð‘– = 1; dan ð·ð‘–ð‘¡ = 0 untuk yang lainnya). Tujuan penelitian ini adalah untuk mengestimasi ð›¼ð‘–ð‘¡ pada saat ð‘¡ â‰¥ ð‘‡0 untuk daerah yang terlanda tsunami (ð‘– = 1). Permasalahan identifikasi yang dihadapi adalah peneliti hanya dapat mengamati nilai ð‘Œð‘–ð¼ð‘¡ bukan nilai ð‘Œð‘–ð‘¡ pada saat ð‘¡ â‰¥ ð‘‡0. Walaupun tidak terdapat metode yang sepenuhnya akurat untuk menentukan ð‘Œð‘–ð‘¡, 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, ð‘Œ1ð‘¡ dapat dihitung sebagai rata-rata tertimbang dari observasi ð‘Œð‘–ð‘¡ (untuk ð‘– = 2, â€¦ , ð½) dari Provinsi-provinsi lain. Dengan demikian, ð‘Œð‘–ð‘¡ = ð›¿ + â^'ð½ð‘—=2 ðœ”ð‘— ð‘Œð‘—ð‘¡ + ð›¼1ð‘¡ð·ð‘¡ + ðœ€1ð‘¡. Untuk mengobservasi variabel-variabel makroekonomi sebelum terjadinya bencana (ð‘¡ < ð‘‡0), persamaan ini dapat diestimasi untuk mendapatkan penimbang yang dialokasikan untuk observasi-observasi dari Provinsi yang berbeda, ðœ”ð‘—. Persamaan dibawah ini akan digunakan untuk mengobservasi variabel-variabel makroekonomi tersebut. Persamaan ini hanya mengandalkan observasi sebelum terjadinya bencana tsunami untuk mendapatkan estimasi parameter ð›¿ dan ðœ”ð‘— : ð‘Œ1ð‘¡ = ð›¿ + â^'ð½ð‘—=2 ðœ”ð‘— ð‘Œð‘—ð‘¡ + ðœ€1ð‘¡ (1) Berdasarkan Abadie et al. (2010), estimasi terhadap ð›¼ð‘–ð‘¡ pada saat ð‘¡ â‰¥ ð‘‡0 dapat dilakukan dengan menggunakan rumusan: Î‡ iÌ‚,t = YiIt â^' Å¶iNt = YiIt â^' [Î´Ì‚ + â^'JJ=2 Ï‰Ì‚,jYjNt] dimana besaran kedua disisi kanan persamaan (2) dihitung dengan menggunakan penimbang yang diestimasi (ðœ”ð‘—Ì‚,) yang diperoleh dari persamaan (1) dan observasi- observasi pasca bencana untuk setiap provinsi yang ada. Jadi, estimasi persamaan (1) hanya digunakan untuk mendapatkan counterfactualdari 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-treat- mentsynthetic 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 200

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 5th International Conferences **on Aceh and Indian Ocean Studies,** 7

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** 185

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, 228

dan

National Economic and Social Development Board (NESDB) of Thailand. Penelitian ini menggunakan **data** 134

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 127
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, 38

keuangan dan jasa.

- Variabel investasi seperti pertumbuhan rata-rata dari pembentukan model. - Jumlah partisipasi

sekolah baik dari tingkat SD, SMP, SMA, dan **199**

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 **109**

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 **201**

(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. 7.1 7.05 lPDRB_Cap 7 6.95 6.9 6.85 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 Year Aceh Synthetic Aceh 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 5 Gap in GRDP pcp, % 0 -5 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 Year 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 silletracy skinder sprimary sjunior ssenior suniv special.PDRB_Cap.1996.2004 special.sagri.1996.2004 special.sman.1996.2004 special.sutil.1996.2004 special.scons.1996.2004 special.strade.1996.2004 special.stourism.1996.2004 special.strans.1996.2004 special.sfin.1996.2004 special.shousing.1996.2004 special.spublic.1996.2004 special.sedu.1996.2004 special.shealth.1996.2004 special.sserv.1996.2004 special.shh.1996.2004 special.Density.1996 Treated 3,859 40,327 25,199 11,811 9,132 9,004 4,882 48,304 4,871 1,318 2,184 12,583 2,866 4,375 2,571 4,706 8,027 4,333 1,443 0,885 0,322 54,644 Synthetic Sample Mean 4,000 4,652 40,542 44,223 25,069 22,400 12,198 12,061 8,950 8,173 8,918 8,314 4,725 4,668 35,911 20,939 15,936 19,084 1,544 2,429 3,538 4,999 12,657 12,644 1,037 1,969 4,420 4,421 2,909 3,938 4,266 6,086 7,308 9,100 7,454 8,206 1,486 2,253 0,931 1.377 0,311 0.33 132,152 163.144 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 â€“ 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) gap in GRDP pcp (in log) gap in GRDP pcp (in log) 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. .4 Aceh Control Provinces .3 .2 .1 0 -.1 -.2 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 year Gambar 8. Gap GRDP per capita antara Aceh dan provinsi placebo .1 Aceh Control Provinces 0 -.1 -.2 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 year 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. 7.15 7.1 GRDP pcp, log 7.05 7 6.95 6.9 Aceh 6.85 Synthetic Aceh 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 Year 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. Aceh East Java Central Java

South Sulawesi South East Sulawesi Central Sulawesi South Kalimantan DI Yogyakarta **North** Sumatra Papua **West** 62

Sumatra Jambi Maluku North Sulawesi

West Java Riau **Bali** Bengkulu **West Nusa Tenggara** Lampung South Sumatra **East Nusa Tenggara** Central **Kalimantan** West **Kalimantan** 60

0 1 2 3 4 5 6 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. 7.1 7.05 GRDP pcp, log 7 6.95 6.9 6.85 Aceh Synthetic Aceh Synthetic Aceh (leave-one-out) 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 year 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. DAFTAR PUSTAKA

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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 rata-rata t test 1 ACEH-SUMATERA UTARA -1274371.9091 -57.0362 *** 2 ACEH-SUMATERA BARAT -106360.3636 -7.2789 *** 3 ACEH-RIAU -95169.9091 -7.9552 *** 4 ACEH-JAMBI 202098.6364 28.7961 *** 5 ACEH-SUMATERA SELATAN -532566.4545 -46.5945 *** 6 ACEH-BENGKULU 339389.4545 50.6719 *** 7 ACEH-LAMPUNG -449807.7273 -54.8445 *** 8 ACEH-DKI JAKARTA -312474.1818 -11.2020 *** 9 ACEH-JAWA BARAT -4675266.3636 -83.8171 *** 10 ACEH-JAWA TENGAH -3187609.7273 -55.1645 *** 11 ACEH- D I YOGYAKARTA 246608.5455 16.1428 *** 12 ACEH-JAWA TIMUR -2848229.6364 -41.1037 *** 13 ACEH-BALI 219841.2727 21.8961 *** 14 ACEH-NUSA TENGGARA BARAT 10638.8182 2.1679 *** 15 ACEH-NUSA TENGGARA TIMUR -37541.1818 -6.3919 *** 16 ACEH-KALIMANTAN BARAT -35234.0909 -6.4195 *** 17 ACEH-KALIMANTAN TENGAH 305113.0909 37.8013 *** 18 ACEH-KALIMANTAN SELATAN 190092.9091 26.9128 *** 19 ACEH-KALIMANTAN TIMUR 214141.0909 20.4710 *** 20 ACEH-SULAWESI UTARA 214462.5455 28.0825 *** 21 ACEH-SULAWESI TENGAH 255974.2727 45.2715 *** 22 ACEH-SELAWESI SELATAN -515843.0909 -40.8994 *** 23 ACEH-SULAWESI TENGGARA 277676.8182 43.2949 *** 24 ACEH-MALUKU 201481.1818 26.8451 *** 25 ACEH-PAPUA 254503.6364 32.5882 *** Sesudah Tsunami rata-rata t test -1264521.8571 -96.9305 -115170.5714 -14.8647 -280969.1429 -11.5421 154480.1429 16.9407 -520846.4286 -41.0979 310787.1429 147.3378 -497380.5714 -117.7792 -279910.1429 -58.8107 -5134163.5714 -67.9557 -2875662.0000 -296.0406 253336.2857 79.0967 -2736115.0000 -475.7014 146757.4286 18.7172 -21750.1429 -12.2439 -182560.0000 -7.8355 -88883.2857 -15.1602 247255.0000 33.8679 147040.5714 27.5745 138102.7143 15.8125 136387.2857 14.2073 212621.0000 20.8814 -635988.1429 -51.3523 212882.5714 38.5848 146357.4286 12.8123 151171.5714 9.8699 *** (***, **, * untuk level signifikansi 1%, 5% dan 10% Tabel A3. Hasil uji beda berpasangan untuk partisipasi sekolah tingkat SMP Sebelum Tsunami rata-rata t test 1 ACEH-SUMATERA UTARA -407585.3636 -75.2607 *** 2 ACEH-SUMATERA BARAT -34640.0000 -17.0277 *** 3 ACEH-RIAU -1657.3636 -0.6561 4 ACEH-JAMBI 62693.4545 19.1489 *** 5 ACEH-SUMATERA SELATAN -126313.1818 -24.0746 *** 6 ACEH-BENGKULU 82021.7273 20.5624 *** 7 ACEH-LAMPUNG -107622.0000 -16.6702 *** 8 ACEH-DKI JAKARTA -285075.2727 -20.5710 *** 9 ACEH-JAWA BARAT -1056223.7273 -19.8810 *** 10 ACEH-JAWA TENGAH -959681.2727 -29.4934 *** 11 ACEH- D I YOGYAKARTA -3388.0000 -0.5304 12 ACEH-JAWA TIMUR -929196.5455 -30.5938 *** 13 ACEH-BALI 13252.7273 2.5260 *** 14 ACEH-NUSA TENGGARA BARAT 35581.0000 13.0053 *** 15 ACEH-NUSA TENGGARA TIMUR 18058.3636 8.5273 *** 16 ACEH-KALIMANTAN BARAT 19360.9091 10.7240 *** 17 ACEH-KALIMANTAN TENGAH 87727.0000 18.9923 *** 18 ACEH-KALIMANTAN SELATAN 68756.2727 17.3300 *** 19 ACEH-KALIMANTAN TIMUR 45126.0000 13.7766 *** 20 ACEH-SULAWESI UTARA 38402.1818 8.6781 *** 21 ACEH-SULAWESI TENGAH 77090.2727 16.8251 *** 22 ACEH-SELAWESI SELATAN -132689.0909 -40.6456 *** 23 ACEH-SULAWESI TENGGARA 70111.2727 28.2555 *** 24 ACEH-MALUKU 49946.8182 11.4985 *** 25 ACEH-PAPUA 65905.7273 15.6686 *** Sesudah Tsunami rata-rata t test -429924.2857 -56.0982 2842.0000 0.4941 -24133.2857 -3.2491 98907.4286 19.0081 -131852.2857 -26.8378 127577.4286 39.5063 -89747.4286 -14.9120 -171657.2857 -39.9746 -1475026.8571 -20.8412 -1022541.4286 -56.9312 73163.7143 16.6003 -947932.8571 -51.4977 50058.7143 12.9960 49091.7143 22.8281 7011.0000 1.3446 134571.8571 9.2381 28935.1429 35.7013 105670.2857 44.7807 71567.5714 33.5729 66476.8571 14.3881 116992.2857 28.6534 -150920.1429 -18.3538 101180.5714 21.6137 88046.7143 19.5303 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 *** 2 ACEH-SUMATERA BARAT -49016.9091 -30.1725 *** 3 ACEH-RIAU -3800.2727 -1.4728 4 ACEH-JAMBI 35635.4545 32.3796 *** 5 ACEH-SUMATERA SELATAN -77412.2727 -25.5546 *** 6 ACEH-BENGKULU 45669.4545 31.0632 *** 7 ACEH-LAMPUNG -43182.0000 -12.0709 *** 8 ACEH-DKI JAKARTA -335688.1818 -61.5653 *** 9 ACEH-JAWA BARAT -578898.9091 -22.4405 *** 10 ACEH-JAWA TENGAH -568739.6364 -32.3356 *** 11 ACEH- D I YOGYAKARTA -43236.2727 -24.9996 *** 12 ACEH-JAWA TIMUR -609744.0000 -32.3730 *** 13 ACEH-BALI -13514.8182 -4.4071 *** 14 ACEH-NUSA TENGGARA BARAT 20673.0000 13.3965 *** 15 ACEH-NUSA TENGGARA TIMUR 19026.4545 8.6612 *** 16 ACEH-KALIMANTAN BARAT 16493.9091 10.5100 *** 17 ACEH-KALIMANTAN TENGAH 50762.7273 20.2360 *** 18 ACEH-KALIMANTAN SELATAN 32865.1818 19.0442 *** 19 ACEH-KALIMANTAN TIMUR 17945.0000 15.0780 *** 20 ACEH-SULAWESI UTARA 9221.4545 3.8637 *** 21 ACEH-SULAWESI TENGAH 46362.0909 26.8380 *** 22 ACEH-SELAWESI SELATAN -94007.6364 -32.9900 *** 23 ACEH-SULAWESI TENGGARA 42313.8182 31.2885 *** 24 ACEH-MALUKU 23793.0909 11.3877 *** 25 ACEH-PAPUA 37118.4545 25.8556 *** -389645.1429 -50.6939 -25115.5714 -3.9716 -17934.8571 -19.6712 73862.8571 9.2918 -98732.2857 -105.9971 96218.8571 9.8348 -35239.0000 -6.5405 -267209.1429 -52.2135 -1004347.5714 -16.6795 -711600.5714 -49.9087 28163.4286 2.4700 -799720.5714 -33.6235 34758.7143 3.9874 41710.8571 7.0785 25262.5714 8.0675 46102.2857 8.2754 103526.4286 11.7581 84226.5714 8.6096 47261.0000 6.9873 51884.5714 7.7862 88621.5714 11.2201 -106745.1429 -22.6625 77888.2857 8.9599 56461.8571 8.4019 70908.1429 8.5908 *** *** *** *** *** *** *** *** *** *** *** *** ** *** *** *** *** *** *** *** ***

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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 *** 2 ACEH-SUMATERA BARAT -1.8744 -4.6851 *** 3 ACEH-RIAU -3.0700 -6.1361 *** 4 ACEH-JAMBI -1.6922 -3.7547 *** 5 ACEH-SUMATERA SELATAN -21.7533 -1.5893 6 ACEH-BENGKULU -1.0389 -1.6636 7 ACEH-LAMPUNG 0.4467 0.8038 8 ACEH-DKI JAKARTA -5.6411 -7.8734 *** 9 ACEH-JAWA BARAT -21.0411 -1.5090 10 ACEH-JAWA TENGAH 6.5967 13.1241 *** 11 ACEH- D I YOGYAKARTA 8.3344 13.5688 *** 12 ACEH-JAWA TIMUR 10.5467 11.8889 *** 13 ACEH-BALI 9.1844 17.4736 *** 14 ACEH-NUSA TENGGARA BARAT 16.8556 14.7403 *** 15 ACEH-NUSA TENGGARA TIMUR 8.7933 6.5052 *** 16 ACEH-KALIMANTAN BARAT 7.7789 10.1517 *** 17 ACEH-KALIMANTAN TENGAH -2.9778 -6.1244 *** 18 ACEH-KALIMANTAN SELATAN -0.5256 -1.0604 19 ACEH-KALIMANTAN TIMUR -1.0678 -2.8581 ** 20 ACEH-SULAWESI UTARA -26.8778 -1.9659 * 21 ACEH-SULAWESI TENGAH -0.5856 -1.1319 22 ACEH-SELAWESI SELATAN 8.8889 10.5413 *** 23 ACEH-SULAWESI TENGGARA 3.5744 6.6013 *** 24 ACEH-MALUKU -15.5938 -1.3441 25 ACEH-PAPUA 27.8333 3.2713 ** -1.7300 -3.0045 -1.2700 -2.2691 -99.0043 -166.1675 -0.1629 -0.2965 -97.1343 -178.5294 0.4943 0.9724 0.4943 0.9724 1.0914 2.0855 -3.4286 -6.1026 -96.4486 -179.1352 5.5486 11.1331 5.7643 13.0979 7.1286 13.7180 7.4914 12.7712 13.5157 17.3424 7.2900 16.6472 5.3614 9.6716 -1.9243 -2.7866 -1.1571 -2.4478 -99.2671 -180.1179 -0.0271 -0.0553 -67.5257 -5.5374 3.7686 6.6479 -97.4371 -192.9584 -54.8429 -4.4675 ** * *** *** * *** *** *** *** *** *** *** *** *** *** *** ** ** *** *** *** *** (***, **, * untuk level signifikansi 1%, 5% dan 10% Tabel A7. Hasil uji beda berpasangan untuk sektor pertanian Sebelum Tsunami rata-rata t test 1 ACEH-SUMATERA UTARA -15252405.5864 -16.3060 2 ACEH-SUMATERA BARAT 2575968.0755 8.3065 3 ACEH-RIAU 739735.5055 0.5762 4 ACEH-JAMBI 5449413.3218 14.2552 5 ACEH-SUMATERA SELATAN -1408256.4955 -4.5437 6 ACEH-BENGKULU 6766763.9273 16.0431 7 ACEH-LAMPUNG -1295841.5964 -2.3693 8 ACEH-DKI JAKARTA 8429934.8582 19.5068 9 ACEH-JAWA BARAT -28770154.0791 -42.6547 10 ACEH-JAWA TENGAH -23162268.4518 -25.8569 11 ACEH- D I YOGYAKARTA 5659807.5227 16.5330 12 ACEH-JAWA TIMUR -33460026.1627 -140.7997 13 ACEH-BALI 3668494.3745 20.6298 14 ACEH-NUSA TENGGARA BARAT 4507240.6573 18.5021 15 ACEH-NUSA TENGGARA TIMUR 4800796.9985 15.1368 16 ACEH-KALIMANTAN BARAT 2757826.5427 13.3638 17 ACEH-KALIMANTAN TENGAH 3291329.0291 18.2685 18 ACEH-KALIMANTAN SELATAN 3767154.5045 10.9004 19 ACEH-KALIMANTAN TIMUR 2086522.6536 7.5503 20 ACEH-SULAWESI UTARA 5381658.6173 17.8971 21 ACEH-SULAWESI TENGAH 5138177.7345 10.3398 22 ACEH-SELAWESI SELATAN -4497044.1000 -51.9447 23 ACEH-SULAWESI TENGGARA 6690327.4836 14.4056 24 ACEH-MALUKU 6243145.5845 19.2672 25 ACEH-PAPUA 4232221.1255 19.0796 Sesudah Tsunami rata-rata t test *** *** 2133619.6479 292276.4128 1054947.6084 -21.1162 -0.1323 -21.8256 *** *** *** 168266.7438 837829.8630 303614.6371 562645.9485 57.5466 -16.9821 47.7211 -27.1784 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 556179.8083 3672642.2501 1546831.0645 443055.9813 2326595.8577 226527.7926 283354.4906 337157.5432 214967.9013 362978.1773 268285.1330 128441.1292 216064.6615 269986.9752 918739.6104 352100.0792 355478.0663 168427.6805 38.4321 -25.8626 -41.9054 29.4045 -45.7912 35.7944 38.1300 30.7487 17.5960 19.8114 17.3374 30.7201 53.8277 20.0406 -18.7404 37.4779 46.2380 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 2 ACEH-SUMATERA BARAT 11504414.7345 13.4320 3 ACEH-RIAU -33450008.9882 -32.9789 4 ACEH-JAMBI 12109586.9173 13.8600 5 ACEH-SUMATERA SELATAN 2227008.1536 1.8710 6 ACEH-BENGKULU 12885917.3755 15.8163 7 ACEH-LAMPUNG 12433607.2891 15.4602 8 ACEH-DKI JAKARTA 12642021.7127 14.8800 9 ACEH-JAWA BARAT 343404.4273 0.2723 10 ACEH-JAWA TENGAH 11248997.6188 13.0151 11 ACEH- D I YOGYAKARTA 12861973.5691 15.8142 12 ACEH-JAWA TIMUR 9113465.8663 12.4193 13 ACEH-BALI 12896030.0382 15.8078 14 ACEH-NUSA TENGGARA BARAT 11429491.7227 11.6531 15 ACEH-NUSA TENGGARA TIMUR 12930166.9221 15.8815 16 ACEH-KALIMANTAN BARAT 12755933.8455 15.4111 17 ACEH-KALIMANTAN TENGAH 12607290.4136 14.6180 18 ACEH-KALIMANTAN SELATAN 9868130.3064 9.2935 19 ACEH-

KALIMANTAN TIMUR -14613613.0509 -8.9944 20 ACEH-SULAWESI UTARA 12342476.4200 14.3200 21 ACEH-SULAWESI TENGAH 12853183.0582 15.7316 22 ACEH-SELAWESI SELATAN 11107968.4045 12.4638 23 ACEH-SULAWESI TENGGARA 12851132.9891 15.9019 24 ACEH-MALUKU 12702208.7464 16.0745 25 ACEH-PAPUA -2252152.5045 -1.2023 *** *** *** *** * *** *** *** 4343641.0000 4529888.6900 -42824097.6957 3737245.9786 -9669960.9071 5358836.2943 4824864.4957 4672737.6157 -1547252.0614 3.5630 3.7539 -24.2765 2.8886 -7.2420 4.5283 4.2277 3.9787 -1.2541 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 3763858.4314 5484446.1000 -991796.3457 5462052.9443 1233968.1814 5469687.4800 5185585.3943 4127767.8814 -444344.1286 -35739057.7643 4766460.6086 5039423.2771 1557989.8686 5037184.8586 5472862.8329 -5574624.2629 3.0002 4.6905 -0.6206 4.6493 0.9518 4.6699 4.2952 3.1719 -0.3047 -12.2199 3.9315 3.9922 1.2623 4.1530 4.6818 -5.4614 * *** *** ** *** *** *** *** ** *** *** *** *** ** *** *** *** *** *** *** *** (***, **, * untuk level signifikansi 1%, 5% dan 10% Tabel A9. Hasil uji beda berpasangan untuk sektor manufaktur Sebelum Tsunami rata-rata t test 1 ACEH-SUMATERA UTARA -9250381.1218 -18.1751 2 ACEH-SUMATERA BARAT 7292428.5182 16.0224 3 ACEH-RIAU -4324376.4291 -2.8134 4 ACEH-JAMBI 9606533.8409 17.5993 5 ACEH-SUMATERA SELATAN 1218586.2218 2.7804 6 ACEH-BENGKULU 11364637.6918 17.6691 7 ACEH-LAMPUNG 7768641.7045 14.1310 8 ACEH-DKI JAKARTA -38803697.4164 -21.7512 9 ACEH-JAWA BARAT -86079145.1018 -14.3564 10 ACEH-JAWA TENGAH -35628256.3664 -18.4472 11 ACEH- D I YOGYAKARTA 9037035.2964 15.7021 12 ACEH-JAWA TIMUR -54008209.7000 -23.4509 13 ACEH-BALI 9478894.6336 16.7813 14 ACEH-NUSA TENGGARA BARAT 11015479.4709 17.2335 15 ACEH-NUSA TENGGARA TIMUR 11392312.2075 18.0560 16 ACEH-KALIMANTAN BARAT 6539257.1709 12.1094 17 ACEH-KALIMANTAN TENGAH 10080602.2373 18.6448 18 ACEH-KALIMANTAN SELATAN 7385149.1073 19.2986 19 ACEH-KALIMANTAN TIMUR -18397937.2182 -9.3655 20 ACEH-SULAWESI UTARA 10403912.4082 16.6395 21 ACEH-SULAWESI TENGAH 10904706.7036 16.8276 22 ACEH-SELAWESI SELATAN 7041531.4873 11.4497 23 ACEH-SULAWESI TENGGARA 11097955.8227 16.8117 24 ACEH-MALUKU 10217098.7064 24.6461 25 ACEH-PAPUA 10609288.5236 17.5443 Sesudah Tsunami rata-rata t test *** -19870716.7286 -19.4056 *** -106044.6143 -0.2227 ** -24576066.8000 -15.2032 *** 2270056.9286 5.8388 ** -7974813.8571 -11.2610 *** 4006663.0857 12.1592 *** -308046.6857 -0.5907 *** -52899565.4571 -30.2622 *** -162215392.0571 -20.3265 *** -50663623.0857 -17.0705 *** 1687121.8571 4.5323 *** -76321074.3571 -23.9793 *** 1759243.0714 3.8263 *** 3488122.5000 9.7962 *** 4144635.1143 13.0770 *** -590149.5286 -1.4868 *** 2971063.7714 8.4613 *** 1199599.3429 3.3129 *** -27611401.2714 -64.9254 *** 2874425.9714 7.3315 *** 3349389.5000 9.1804 *** -2207281.4571 -3.4585 *** 3456124.9857 9.2296 *** 3772744.5286 11.6018 *** 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 *** 2 ACEH-SUMATERA BARAT -306837.4363 -6.8963 *** 3 ACEH-RIAU -192325.9876 -12.2059 *** 4 ACEH-JAMBI -9555.7785 -2.5249 ** 5 ACEH-SUMATERA SELATAN -265921.9105 -11.4790 *** 6 ACEH-BENGKULU 32333.3875 7.5080 *** 7 ACEH-LAMPUNG -73026.9320 -5.9787 *** 8 ACEH-DKI JAKARTA -3429260.9983 -7.4576 *** 9 ACEH-JAWA BARAT -6588236.4116 -24.3573 *** 10 ACEH-JAWA TENGAH -1200818.6850 -11.0625 *** 11 ACEH- D I YOGYAKARTA -49649.8203 -6.4948 *** 12 ACEH-JAWA TIMUR -3889218.0206 -12.0165 *** 13 ACEH-BALI -217098.2581 -14.1003 *** 14 ACEH-NUSA TENGGARA BARAT 24923.6905 4.7721 *** 15 ACEH-NUSA TENGGARA TIMUR 7788.0679 4.1709 *** 16 ACEH-KALIMANTAN BARAT -86934.3573 -7.5650 *** 17 ACEH-KALIMANTAN TENGAH 25695.3155 2.9661 *** 18 ACEH-KALIMANTAN SELATAN -153657.3616 -6.2230 *** 19 ACEH-KALIMANTAN TIMUR -156525.2513 -23.6052 *** 20 ACEH-SULAWESI UTARA -19421.0661 -2.9115 *** 21 ACEH-SULAWESI TENGAH 13214.2274 1.4667 22 ACEH-SELAWESI SELATAN -321777.1109 -13.4358 *** 23 ACEH-SULAWESI TENGGARA 35410.8068 5.6617 *** 24 ACEH-MALUKU 25560.8192 4.3894 *** 25 ACEH-PAPUA 11985.5816 2.9409 ** -706098.1686 -32.5135 -311796.9414 -49.8828 -286429.4814 -14.3334 -29755.4800 -12.2820 -242693.3143 -35.3289 58816.4343 7.6487 -32515.7457 -9.4631 -2236209.6600 -24.8225 -9129969.4943 -20.7766 -1330902.2214 -22.4495 -81200.8557 -24.9711 -4383654.2829 -44.6691 -294534.0686 -25.5917 32855.6200 5.5717 46997.7286 6.0337 -25725.7357 -4.3166 17009.8229 2.3553 -46401.9429 -10.6636 -233072.3714 -31.0355 -43765.5486 -23.1064 -17511.8100 -3.9367 -374772.9500 -14.9989 20284.5529 4.2601 61163.1229 6.4093 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 rata-rata t test 1 ACEH-SUMATERA UTARA -

3893840.1722 -20.5915 2 ACEH-SUMATERA BARAT -1799476.0718 -9.1835 3 ACEH-RIAU 225001.8609 4.6541 4 ACEH-JAMBI 1671471.3718 12.7472 5 ACEH-SUMATERA SELATAN -891693.2491 -5.7376 6 ACEH-BENGKULU 1729417.9845 11.1819 7 ACEH-LAMPUNG 314312.7264 1.7732 8 ACEH-DKI JAKARTA -23183251.6264 -31.4776 9 ACEH-JAWA BARAT -17628895.6800 -12.8205 10 ACEH-JAWA TENGAH -12632186.4191 -11.8137 11 ACEH- D I YOGYAKARTA -775579.7091 -2.2364 12 ACEH-JAWA TIMUR -20711661.9573 -15.5663 13 ACEH-BALI -837093.7464 -2.2231 14 ACEH-NUSA TENGGARA BARAT 908365.3473 4.1477 15 ACEH-NUSA TENGGARA TIMUR 807374.2020 4.7985 16 ACEH-KALIMANTAN BARAT 333269.9582 1.1983 17 ACEH-KALIMANTAN TENGAH 1369157.4500 9.3018 18 ACEH-KALIMANTAN SELATAN 890735.2536 5.4764 19 ACEH-KALIMANTAN TIMUR 1104995.2091 6.9867 20 ACEH-SULAWESI UTARA 542919.0155 4.1307 21 ACEH-SULAWESI TENGAH 1408772.4682 15.6411 22 ACEH-SELAWESI SELATAN -1478296.7436 -6.9569 23 ACEH-SULAWESI TENGGARA 1782093.0600 14.3225 24 ACEH-MALUKU 1796090.2373 10.2771 25 ACEH-PAPUA 1191738.5064 7.3345 Sesudah Tsunami rata-rata t test *** *** *** *** *** *** -4989367.1143 -271842.6571 295148.0571 4156175.5000 125152.6143 4255942.4000 2860164.4857 -12.0391 -2.5108 1.9675 22.7432 0.7830 25.9141 21.7042 *** *** *** ** *** ** *** *** -35567833.3857 -17649957.7143 -11684624.3429 2344541.7571 -21543310.9857 1938671.9857 3709052.0571 2748423.9571 2402648.4714 -19.4668 -20.4850 -20.5878 26.6362 -15.5835 23.9876 24.2094 28.7196 42.2414 *** *** *** *** *** *** *** *** *** 3376152.0571 3027193.8000 3430770.0429 2550451.4714 3087146.2429 -83898.1429 4203014.0000 4568202.2000 2921979.7286 28.5152 28.9378 25.1125 25.5471 45.2882 -0.9623 23.7062 23.7874 26.6573 *** ** * *** (***, **, * untuk level signifikansi 1%, 5% dan 10% Lampiran B.Statistik Descriptive untuk Provinsi Phang Nga Agriculture 14000 3500 12000 3000 10000 2500 8000 2000 6000 PhangNga 1500 4000 Rata-rata 1000 2000 500 0 0 1995 1997 1999 2001 2003 2005 2007 2009 2011 Mining 1995 1997 1999 2001 2003 2005 2007 2009 2011 Rata-rata PhangNga Manufacturing 40000 5000 30000 4000 3000 20000 PhangNga 2000 10000 Rata-rata Axis Title 1000 0 0 1995 1997 1999 2001 2003 2005 2007 2009 2011 Electricity PhangNga Rata-rata 1995 1998 2001 2004 2007 2010 Construction Wholesale 6000 20000 4000 15000 PhangNga 2000 10000 PhangNga Rata-rata 5000 Rata-rata 0 1995 1997 1999 2001 2003 2005 2007 2009 2011 0 Hotels Transport 6000 15000 4000 10000 2000 PhangNga 5000 PhangNga Rata-rata 0 Rata-rata 0 1995 1997 1999 2001 2003 2005 2007 2009 2011 8000 6000 4000 2000 0 8000 6000 4000 2000 0 Financial 1995 1997 1999 2001 2003 2005 2007 2009 2011 Public Adm 1995 1997 1999 2001 2003 2005 2007 2009 2011 Real estate 15000 PhangNga Rata-rata 10000 5000 0 1995 1998 2001 2004 2007 2010 PhangNga Rata-rata PhangNga Rata-rata 2500 2000 1500 1000 500 0 Health PhangNga Rata-rata Community Private House 2500 300 2000 250 1500 200 PhangNga 150 1000 PhangNga 100 500 Rata-rata 50 Rata-rata 0 0 1995 1997 1999 2001 2003 2005 2007 2009 2011 GPP Electricity 150000 6000 100000 PhangNga Axis Title 4000 50000 2000 PhangNga 0 Rata-rata 0 Rata-rata 1995 1997 1999 2001 2003 2005 2007 2009 2011 1995 1998 2001 2004 2007 2010 150000.000 100000.000 50000.000 0.000 Deposit PhangNga Rata-rata 1995 1998 2001 2004 2007 2010 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** **68**

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** **94**

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** **29**

Pathom 0 0 0

0 0 0 0 0 **Nakhon Phanom 0 0 0 0.** 003 **0** 0 **0.** 001 **0.** 003 **Nakhon** **29**

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** 0 Narathiwat **0** **1**

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.** **79**

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** **1**

Tabel C1â€¦ Lanjutan Province

Amnat Charoen Ang Thong Buri Ram Chachoengsao Chai Nat Chaiyaphum Chanthaburi Chiang Mai Chiang Rai Chon Buri Chumphon Kalasin Kamphaeng Phet Kanchanaburi Khon Kaen Krabi Lampang Lamphun Loei Lop Buri Mae Hong Son Maha Sarakham Mukdahan Nakhon Nayok Nakhon Pathom Nakhon Phanom Nakhon Ratchasima Nakhon Sawan Nakhon Si Thammarat Nan Narathiwat Nong Bua Lam Phu Nong Khai Nonthaburi Pathum Thani Pattani Phangnga **8**

Finance Housing 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.002 0 0.104 0 0.086 0.292 0 0 0 0 0 0 0 0 0 0 0 0 0 0.043 0 0 0 0 0 0 0 0 0 0 0.049 0 0 0 0 0 0 0 0 0 0 0 0 0 0.14 0 0 0 0 0 0 0 0 0 Public 0 0.071 0 0 0 0 0 0 0 0 0 0.083 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.098 0 0 0 Education Health 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.11 0.003 0.001 0.541 0.123 0 0 0.023 0.085 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.138 0.117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 Service 0 0 0 0 0 0 0 0 0 0 0 0.219 0.132 0 0 0 0 0 0 0 0 0 0 0 0.001 0 0 0 0 0 0 0 0 0 0 0 HouseHold 0 0.019 0 0 0 0 0 0 0 0 0 0.042 0.181 0 0.108 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.251 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** **84**

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** **1**

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

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Saraburi 0 0 0 0 0 0 0 0 Satun 0 0 0 0 0 0 0 0

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Phra Nakhon Si Ayutthaya **0 0 0 0 0 0 0** **119**

Phrae 0 0 0 0 0 0 0 Phuket 0 0 0 0 0 0 0 Prachin

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Bulletin of Indonesian Economic Studies (BIES) How Resilient is **the** Economy **to** 188

a Catastrophic Natural Disaster? Lessons Learned from a Developing Country? Inggridâ€ Siana Halimâ€¡ Abstract Recent research in developed countries shows an

adverse effect of natural **disasters on the economy.** 213

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 * Funding from the

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50 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,** **131**

suggesting that the loss from disasters increase at a relatively low

level of gross domestic product (GDP) per capita, **184**

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 Japanâ€™s GDP, whereas in a developing country, like Haiti, the disaster costs accounted for about 120% of the countryâ€™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.** **222**

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,** **24**

a major island in the western part of Indonesia. It subsequently generated ferocious tsunami waves

in the provinces of Aceh and North Sumatra **208**

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** **151**

death toll of the Aceh tsunami was

more than 165 **,000 people and over** a half **million** people **were** **204**

displaced. The total estimate of economic **damages and losses** was approximately **$4.** 5 **billion** **47**

which was equivalent to 97.4% of Acehâ€™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-Ã -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** **167**

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).** **6**

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-** **221**

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** **45**

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.** **16**

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** **23**

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** **215**

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 Acehâ€™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 Acehâ€™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** 174

Kobeâ€™s GDP per capita is about 9%, our empirical estimates reveal that, on average, Acehâ€™s GDP per capita was about 29.67%

lower than it would have been had the tsunami not occurred. 107

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.** 137

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 countryâ€™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** 64

describes some background on

the 2004 Indian Ocean Tsunami in Indonesia and 198

Acehâ€™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** 140

robustness tests, and followed by discussion of the main findings. Section 6 concludes. 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 ETAâ€™s activity leads to a 10% drop in GDP per capita

of the Basque country (Abadie and Gardeazabal 2003). 192

2. THE

GROWTH EFFECTS OF NATURAL DISASTERS: THEORIES **AND** 95

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** 161

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** 83

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.** 179

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** 78

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** 117

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** 212

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** 24

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 26

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** 181

(2008). estimates imply

that natural disasters are more **likely to** 220

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** 210

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.** 182

His study suggests a climatic disaster lowers

GDP per capita by approximately **0.6% in the long-** 136

run, while droughts produce the largest effect which account for 1% cumulative losses of

GDP per capita. In addition, the 223

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** 26

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 Raddatzâ€™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 countryâ€™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** 195

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** 73

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.** 73

Cavallo et al. (forthcoming) also

apply the synthetic control method to figure out **the** trajectory **of** GDP of **the** 160

disaster affected country. They do not find economically

and statistically significant effects of large **disasters on the** 95

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 countryâ€™s level of development.** 25

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** 78

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** 158

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** 138

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 Japanâ€™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 Kauaiâ€™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** 165

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 ACEHâ€™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** 144

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** 37

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 214

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 Acehâ€™s GDP** 47

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 Acehâ€™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** 166

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 77

provinceâ€™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** 122

still dependent to a great extent on the natural resources. In 1998, oil and gas accounted for approximately 65% and 92.70% of Acehâ€™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** 153

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

Acehâ€™s economy continued to decline because **of the** 190

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 Acehâ€™s economy. They were equal to 32.20% and 43% of the province GDP respectively. The sluggishness and volatility in the Acehâ€™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** 20

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

Acehâ€™s GDP growth **in 2005** declined **by 7-28** 46

% 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, 176

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). 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 Acehâ€™s police. 4. EMPIRICAL METHODOLOGY

We are interested in testing whether a **large** tsunami affects **the** 69

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 20

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** 45

we observe 26 provinces in Indonesia for the period ð‘¡ = 1995, â€¦ ,2004, â€¦ ,2011.5 Let ð‘– = 1 be the province of Aceh, and ð‘– = 2, â€¦ ,26 be the other provinces that serve as the potential controls for Aceh. Here, we let ð‘‡0 = 2004 be the year when tsunami struck Aceh. We denote ð‘Œð‘–ð¼ð‘¡ as GDP per capita in the presence of the tsunami, while ð‘Œð‘–ð‘¡ 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 ð‘‡0. Hence, ð‘Œð‘–ð¼ð‘¡ = ð‘Œð‘–ð‘¡ for ð‘¡ âˆˆ [0, â€¦ , ð‘‡0 â€“ 1]. The economic

effect of the tsunami **for** province **ð‘– at time ð‘¡ is** 141

written as ð›¼ð‘–ð‘¡ = ð‘Œð‘–ð¼ð‘¡ âˆ’ ð‘Œð‘–ð‘¡ (1) We also have ð·ð‘–ð‘¡, the binary variable

that takes a **value** of **one if** province **ð‘– is exposed to the** tsunami **at time ð‘¡ and zero otherwise.** We can observe **the** post-tsunami **outcome for** province **ð‘– at time ð‘¡** as: **ð‘Œð‘–ð‘¡** 10

= ð‘Œð‘–ð‘¡ + ð›¼ð‘–ð‘¡ð·ð‘–ð‘¡ (2) In our case, the Indonesian province of Aceh is the only province that severely hit by the tsunami after ð‘‡0. Therefore, ð·ð‘–ð‘¡ = {1 if0ð‘– =ot1hearnwdisð‘¡e> ð‘‡0 Our goal is to estimate ð›¼ð‘–ð‘¡ for Aceh (ð‘– =1) and for all > ð‘‡0 , or: ð›¼1ð‘¡ = ð‘Œ1ðŸ¼ð‘¡ âˆ’ ð‘Œ1ð‘ð‘¡ = ð‘Œ1ð‘¡ âˆ’ ð‘Œ1ð‘ð‘¡ (3) The above equation implies that ð‘Œ1ðŸ¼ð‘¡ is observed in the period 2005-2011, whereas ð‘Œ1ð‘ð‘¡ is unobserved. We need to estimate ð‘Œ1ð‘ð‘¡ which is the counterfactual of Aceh or

the synthetic control unit. **Abadie, Diamond and Hainmueller (2010)** 203

show that: ð‘Œ1ð‘ð‘¡ = ð›¿ð‘¡ + ðœ†ð‘¡ðœ‡ð‘– + ðœ†ð‘¡ðœ‡ð‘– + ðœ€ð‘–ð‘¡ (4) where ð›¿ð‘¡

is an unobserved **common time-** dependent **factor,** ðœ†ð‘¡ **is a vector of** unobserved **parameters,** ð‘ð‘– **is a vector of observed covariates** 15

for GDP per capita that is **not** affected **by the** tsunami, ðœ‡ð‘¡ **is** 170

unknown common factors, ðœ‡ð‘– **is** a **province-specific unobservable, and** ðœ€ð‘–ð‘¡ are **the error** 23

terms which represent unobserved transitory shocks at the level of province (ð¸(ðœ€ð‘–ð‘¡) = 0

for all ð‘– and ð‘¡). For constructing **the synthetic control unit,** 89

we define a (25 x

1) vector of weights ð‘Š = (ð‘¤2, â€¦ , ð‘¤26)â€² **such that** ð‘¤ð‘– â‰¥ **0 for** ð‘– = **2,** â€¦ ,26 **and** 28

âˆ‘2ð‘–=62 ð‘¤ð‘– =

1. Each value of ð‘Š indicates **a potential synthetic control** unit **for** 6

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** 207

have proliferated today, becoming 34 provinces. However, to maintain consistency, our analysis still uses 26 provinces. 26 26 26 26 âˆ‘ ð‘¤ð‘– ð‘Œð‘–ð‘¡ = ð›¿ð‘¡ + ðœ†ð‘¡ð‘¡ âˆ‘ ð‘¤ð‘–ð‘ð‘– + ðœ‡ð‘¡ð‘¡ âˆ‘ ð‘¤ð‘– ðœ‡ð‘– + âˆ‘ ð‘¤ð‘– ðœ€ð‘–ð‘¡ ð‘–=2

ð‘–=2 ð‘–=2 ð‘–=2 Suppose there **is** a **set of** 154

weights (ð‘¤2âˆ—, â€¦ , ð‘¤2âˆ—6) that best reproduces Acehâ€™s pre-tsunami characteristics such that: 26 26 26 âˆ‘ ð‘¤ð‘–âˆ— ð‘Œð‘–ð‘¡=1 = ð‘Œ11, â€¦, âˆ‘ ð‘¤ð‘–âˆ— ð‘Œð‘–ð‘¡‡0 = ð‘Œ1ð‘¡‡0 and âˆ‘ ð‘¤ð‘–âˆ— ð‘ð‘–

= ð‘1 ð‘–=2 ð‘–=2 ð‘–=2

Abadie, Diamond and Hainmueller (2010) prove **that, as long as** **159**

the condition in (6) holds

and the number of pre- tsunami observations **is large** as compared with **the** level **of the transitory shocks,** **4**

then 26 ð‘Œ1ð‘¡ = âˆ‘ ð‘¤ð‘–âˆ—ð‘Œð‘–ð‘¡ ð‘–=2 Ultimately, the estimator for ð›¼1ð‘¡6 for ð‘¡ âˆˆ [ð‘‡0 + 1, â€¦ , ð‘‡] is given by 26 ð›¼Ì‚1ð‘¡ = ð‘Œ1ð‘¡ âˆ’ âˆ‘ ð‘¤ð‘–âˆ—ð‘Œð‘–ð‘¡ ð‘–=2 It should be noted that equation (6) can hold precisely under the condition (ð‘Œ11,â€¦,ð‘Œ1ð‘‡0,ð‘1â€²) ÃŽ {(ð‘Œ21,â€¦,ð‘Œ2ð‘‡0,ð‘2â€²), â€¦ . . , (ð‘Œð‘–âˆ’11,â€¦,ð‘Œð‘–âˆ’1ð‘‡0,ð‘ð‘–âˆ’â€²+1)}, implying that the observations

for the treated and control units have **to** fall within **the** **85**

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 ð‘1 during the pre-tsunami period. Strictly speaking, our main task is to construct some optimal weights ð‘Šâˆˆâ„—such that both equation (6) and equation (7) hold approximately.

Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010) suggest selecting ð‘ŠâˆˆÂ— **to** minimise **the** **69**

differences between the pre- disaster predictors **of the treated unit and** a **synthetic control,** **4**

or: ð‘˜ âˆ‘ ð‘£ð‘š (ð‘‹1ð‘š âˆ’ ð‘‹0ð‘šð‘Š)2 ð‘š=1 where ð‘‹1 is a (k x

1) vector including **the** observations **of the pre-** disaster predictors **of the treated** **4**

unit, ð‘‹0 is a (k x i) matrix consisting of the value of the same predictors

for the control units, and ð‘£ð‘š **is a** vector **of weights** **145**

on the predictors of the control units representing the significance

that we assign to the m-th variable. The **74**

selection of ð‘£ð‘š is fundamentally important because it determines the mean squared error of our outcomes of interest. Intuitively, the best choice

is to choose ð‘£ð‘š such **that the mean squared prediction error** **40**

is minimised. In other words, the set of ð‘£ð‘š 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** **219**

a synthetic control unit, defined **as a weighted average of** **4**

a linear combination of untreated units that best replicates the

pre-intervention characteristics of the treated unit. Since our outcome **of** interest is **the** 85

evolution of Acehâ€™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, ð'£ð'š . <Insert Table 1 here> Table 2 reports the optimal weights (ð'Šâˆ—) 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** 10

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** 196

current application, we plot the outcome of interest

for the treated unit and the synthetic provinces over **the pre-** treatment **period** in which **the** 118

root mean square error (RMSPE) between **the** 218

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 Acehâ€™s GDP per capita exhibited a sharp fluctuation. The instability of oil and gas production

due to the depletion of oil and gas reserves 146

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> 7 Unlike **the** 86

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 Acehâ€** 76

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 Acehâ€™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** 46

Acehâ€™s GDP per capita **could** fall **by 7% to 28** 20

%, 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** 142

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.** 74

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 Acehâ€™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** 36

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** 40

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** 35

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,** **114**

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** **130**

indeed identical for the 1995-1999 periods. Needless to say, we do find negligible effects of the placebo intervention on Acehâ€™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** **90**

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. **15**

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** **97**

and

a negative effect of the disaster **on GDP per capita** **64**

as shown by Aceh is 1/24 â‰ˆ 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** **205**

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** 59

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 173

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.** 36

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 163

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 countryâ€™s level of economic and institutional 180

development, in which

developing countries tend to be more vulnerable **to** 226

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** Kobeâ€™s **GDP** 116

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 Acehâ€™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 224

in the aftermath of natural catastrophes. **Developed countries** generally show **counter-cyclical** 172

behaviours of fiscal policy

in the aftermath of natural disasters. On the other hand,	**80**

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 Acehâ€™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**	**98**

after the December 2004 tsunami. Second, the difference in the economic structure to some extent is also imperative. Although the Acehâ€™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**	**82**

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**	**171**

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**	**46**

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.**	**123**

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 Acehâ€™s GDP**	**104**

in 2003. According to international experience, the affected economy will encounter serious difficulties in returning the economy

to its pre-disaster level if **the**	**225**

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	**56**

applying a-quasi-experimental strategy and focusing exclusively on single developing country data

to identify the causal **effects of** large **natural disasters on the** 150

short- and the medium-term of income per capita. Importantly, this

method allows us to control for endogeneity between economic variables **and** 183

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** 90

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** 193

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 â€“ Sri Lanka, India, and Thailand, 34

are still an open question. REFERENCES

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TABLES AND FIGURES TABLE 1 Pre-tsunami Predictor Balance (Average over the period 1995-2004) Synthetic Sample Aceh Aceh Mean Real per capita PDB (1995, log) Real per capita PDB (1996, log) Real per capita PDB (2000, log) Investment (%) Government expenditure (%) Population density Sectoral shares (%) 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 business services Services Human capital Primary school enrollment (log) Junior high school enrollment (log) Senior high school enrollment (log) University enrollment (log) Literacy (%) 7.099685 7.058386 6.64604 7.100647 7.074188 6.672116 6.994563 7.034157 6.676691 13.90018 20.36956 27.78469 8.873987 8.658222 13.54565 1.842523 1.900549 2.010857 20.20574 14.67455 13.54565 28.88107 34.40745 9.682374 24.74944 17.72269 14.95265 0.180179 0.448144 0.84913 4.130182 4.098754 5.886326 8.398579 12.18992 16.90239 5.498841 4.78916 7.98 0.953526 4.299466 4.781665 6.92678 7.369867 11.93058 5.754879 5.774179 5.810485 5.179388 5.196426 5.235212 4.941334 4.999542 5.028335 4.652602 4.561505 4.60584 93.27 93.88334 89.62 TABLE 2 Weights of Provinces in the Synthetic Aceh Province Weight Province Weight

North Sumatra West Sumatra Riau Jambi South Sumatra Bengkulu Lampung West Java Central Java DI Yogyakarta **East Java Bali** 0 **West Nusa Tenggara** 0 **East Nusa Tenggara** 0.654 **West Kalimantan** 0 **Central Kalimantan** 0 **South Kalimantan** 0 **North Sulawesi** 0 **Central Sulawesi** 0 **South Sulawesi** 0.048 **South East Sulawesi** 0.128 **Maluku** **18**

0 Papua 0 0 0 0 0 0 0.050 0 0 0 0.120 0 67

FIGURE 4 GDP **per capita Gaps in** Aceh **and Placebo Gaps in** 23 **Control** **10**

Provinces Gap in GRDP pcp, % -40 -30 -20 -10 0 10 Year 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2002 Note: The minimised RMSPE of the pre-tsunami periods after the exclusion of the year FIGURE 3 GDP per-capita Gap: Aceh vs. Synthetic Aceh GRDP pcp, log 6.85 6.9 6.95 7.05 7 7.1 Year 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 synthetic Aceh Aceh

FIGURE 2 Trends in GDP per-capita: Aceh **vs. Synthetic** **6**

Aceh GRDP pcp, log Year Synthetic Aceh Aceh 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 6.85 6.9 6.95 7.05 7.1 7

FIGURE 1 Trends in GDP per-capita: Aceh **vs. Synthetic** **6**

Aceh TABLE 3 Difference in GDP per capita between Aceh vs. Synthetic Aceh Year Deviation % Deviation 1995 1,141.17 9.98 1996 745.19 6.28 1997 314.23 2.61 1998 -221.48 -1.97 1999 -528.89 -4.84 2000 -942.68 -8.71 2001 -2,183.38 -20.41 2002 244.77 2.36 2003 251.45 2.43 2004 -687.69 -6.49 2005 -1,827.89 -16.88 2006 -1,982.80 -18.17 2007 -2,369.14 -21.37 2008 -3,487.81 -30.62 2009 -4,178.40 -36.36 2010 -4,416.57 -37.48 2011 -4,713.41 -38.39 Average -2,957.96 -25.72 .4 .3 gap in GRDP pcp (in log) .2 .1 0 -.1 -.2 Aceh Control Provinces 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

year FIGURE 5 GDP **per capita Gaps in** Aceh **and Placebo Gaps in** **35**

19 Control Provinces .1 Aceh Control Provinces gap in GRDP pcp (in log) 0 -.1 -.2 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 year Note: The provinces with RMSPE 2x higher than the RMSPE of Aceh are discarded 7.1 7.15 GRDP pcp, log 7.05 7 6.9 6.95 Aceh 6.85 Synthetic Aceh 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 Year FIGURE 6 1999 Placebo Tsunami, Trends in GDP per-capita: Aceh vs. Synthetic Aceh Aceh East Java Central Java

South Sulawesi South East Sulawesi Central Sulawesi South **62**

Kalimantan DI Yogyakarta **North** Sumatra Papua **West**

Sumatra Jambi Maluku North Sulawesi

West Java Riau **Bali** Bengkulu **West Nusa Tenggara** Lampung South Sumatra **East Nusa Tenggara** Central **Kalimantan** West **Kalimantan** **60**

0 1 2 3 4 5 6 FIGURE 7 Ratio of Post-tsunami RMSPE and Pre-tsunami RMSPE: Aceh and 23 Control Provinces 7.1 7.05 GRDP pcp, log 7 6.95 6.9 6.85 Aceh Synthetic Aceh Synthetic Aceh (leave-one-out) 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 year FIGURE 8 Leave-One-Out Tests DATA APPENDIX The data set was taken from the Indonesian Central Bureau of Statistics (BPS) and includes 26 Indonesian provinces. The data set is annual and covers the period 1995- 2011. All nominal variables are converted in 2000 prices. Basically, it consists of the regional GDP per capita and its main ingredients. We follow Abadie and Gardeazabal (2003) to include 9 sectoral

value added of the economy, that **227**

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 business services,** and **services.** **49**

The share of each sector

is obtained by dividing the value added of each sector by the total regional GDP. **Population** density is considered **as** **52**

well. It is measured as total population divided by land area in kilometre square. As suggested by modern growth literature, we incorporate the role of structural and stabilization policies in the areas of financial development, and macroeconomic policies. Financial development is approximated by the share of gross fixed capital formation to GDP, whereas the fiscal side of the economy is

measured by the ratio of government expenditure to GDP. Finally, **the** **25**

proxies for human capital are captured by the number of primary school enrolment, the

number of junior **high school** enrolment, the **number of** senior **high school** enrolment, the **number of** **124**

university enrolment. They are expressed in logarithms. The other variable is the adult literacy rate. 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 **2**

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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 Acehâ€™s economy on the other provinces only during the pre-disaster period.**

and/or peer-review under responsibility of ICSM 2014 **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 Acehâ€™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.** 108

The final section summarizes and concludes. 2. Methods and Data 2.1. 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 (ðˆ â˜convergence) occurs when the

dispersion of per capita income across provinces declines **over time. The** 32

second notion is beta convergence (ðœ· â˜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, ðœ· â˜convergence holds when the relationship

between growth in income and its initial level is negative. 32

The results do show the present of ðœ· â˜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** 175

aftermath of natural disasters. Table 1. The estimated parameters for growth determinants, 2003-2008 Parameter 2003 2004 2005 2006 2007 2008 Intercept Initial income Share of government Share of capital Literacy rate 0.871 -0.149 -1.020 -0.192 0.302 -0.304 -0.073 -0.315 0.126 0.860 -1.400 -0.071 -0.166 -0.095 2.010 1.610 -0.009 -0.324 0.038 -1.590 -0.885 -0.077 -0.325 0.139 1.500 3.160 -0.086 -0.435 0.556 -2.710 ? ? 2 ? 2 18.500 15.500 16.400 14.700 16.600 14.500 0.238 0.365 0.254 0.219 0.224 0.250 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** Acehâ€™s **economy** 155

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 Sumatraâ€™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 2

of Sumatra Island. The results demonstrate the existence of ð›½ â^'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 Acehâ€™s economy on the other provinces only pertains to the sample before the disaster. 2

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(DIKTI) under a grant from

SP-DIPA-023.04.2.415015/2014. References [1] 168

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Halim S, Inggrid, Ottemoesoe RDS. The

synthetic regression method: how the Indian Ocean Tsunami affects growth trajectories. 7

Peper was presented at The International Conference on Applied Statistics (ICAS), September 16-19, 2013. 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 North Sumatera West Sumatera Riau Jambi South Sumatera Bengkulu Lampung 76

Banda Aceh Medan Padang Pekanbaru Jambi Palembang Bengkulu Bandar Lampung 129

95.317 5.550 98.669 100.353 101.447 103.610 104.757 102.262 105.265 3.592 -0.950 0.534 -1.590 -2.990 -3.792 -5.448 Fig A. The map of Sumatra Island Lampiran E3. Naskah untuk Publikasi di

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Banda Aceh, 17-18 November 2014

Assessing the Impact of the Indian Ocean Tsunami on the Economy: Evidence from Indonesia and Thailand 7

Inggrid,â€ & Siana Halim,â€¡ and Indriati Njoto Bisonoâ€¡ Abstractâ€" 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 34

negatively affects

per capita gross domestic product (GDP) of the exposed **provinces.** 23

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. Keywordsâ€"natural disaster, economic impact, developing country. INTRODUCTION SMALL but growing literature has been devoted to study the economic consequences of Adisasters 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 52

trajectory.

In contrast, endogenous growth models provide less clear-cut 28

explanation of disaster effects. A class of endogenous growth models Ã 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 5

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** 24

path. Another variant of the endogenous growth theory with a production function that exhibits increasing returns to scale * This research was made possible by funding

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inggrid@peter.petra.ac.id). 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** 164

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** 80

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** 186

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),** 66

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** 37

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,** **66**

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 Acehâ€™s GDP was approximately 4% of Indonesian GDP whereas the combined six provinces of Thailand

> **accounted for only 2.** 7% **of the national GDP** **197**

(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** **4**

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** **135**

our work also complement a recent study based on developed country data [12] and corroborate disaster theories about

> **a non-linear relationship between** a countryâ€™s **income per capita disaster** **149**

shocks.

> **This paper proceeds as follows. In Section 2, we** give an overview **of** estimating **the** distributional effect **of** **101**

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** **30**

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** **40**

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 Indonesia14

and n =35 provinces for Thailand15) for the period t =1995,â€¦,2004,â€¦,2012. Let i =1 be the exposed province, and i =2,â€¦, n be the other provinces that serve as the potential control group or the donor pool for the affected province. Here, we let T0 =2004 be the year when the tsunami struck Indonesia and Thailand. We denote YitI as the regional GDP per capita in the presence of the tsunami, while YitN 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 T0 . Hence, YitI =YitN for tâˆˆ[0,â€¦, T0 - 1]. The economic

effect of the tsunami **for** province **i at time t** is written as: **?it** **4**

? YitI ? YitN (1) We also have Dit , 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: Yit ?YitN **??it it D** **44**

(2) For each model, we assume that the only first province in Indonesia and Thailand hit by the tsunami after T0 . Therefore, ð·ð'–ð'¡ = {1 ð'–ð'"0ð'– =ð'œð'¡â„Ž1ð''ð'Žð'Ÿð'›ð'¤ð''ð'–ð' ð'¡ð''> ð'‡0 Our goal is to estimate ?it for the eight affected provinces (i =1) and for all t >T0 , or: ?1t ? Y1tI ? Y1Nt ? Y1t ? Y1tN (3) The above equation implies that Y1It is observed in the period 2005-2012, whereas Y1Nt is unobserved. We need to estimate Y1tN which is the counterfactual of the exposed provinces or the synthetic control units. It is shown in [12] that: YItN ??t ??tZi ??t?i ??it (4) where

?t is an unobserved **common time-** dependent **factor, ?t is a vector of** unobserved **parameters,** Zi **is a vector of observed covariates** **15**

for important ingredients for a growing GDP that is not affected by the tsunami, ?t is

unknown common factors, ?i is a **province- specific unobservable, and** ?it are **the error** **23**

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** **32**

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), **110**

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(?it) ? 0

for all i and t). For constructing **the synthetic control unit,** **89**

we define a (rx1)

vector of weights W ? (w2,.... wn)' **such that** wi ? **0 for** i **=2,â€¦,** n **and** **28**

?ni?2wi

?1. Each value of W indicates **a potential synthetic control** unit **for** **6**

each exposed provinces. We thus state the outcome for each synthetic control as: n n n n ?wiYit ??t ??t? wiZi ??t?wi?i ??wi?it

(5) i?2 i?2 i?2 i?2 i?2 **156**

We need

to choose a set of weights (w* 2,....,wn*)' **that** **86**

best reproduces pre-tsunami characteristicsoftheexposedprovincessuchthat: ? w*Yi1 ? Y11,..., ? w*YiT0 1T0 and ? w*Zi n n n Y (6) i i ? i ?

Z 1 i?2 i?2 i?2 **194**

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** **4**

[11], then Y1Nt ? ? w*iYit n (7) i?2 Ultimately, the estimator for ?1t for tâˆ’[T0 +1,â€¦,T] is given by ?Ë†1t ? Y1t ? ?1n?2 wi*Yit (8) It should be noted that equation (2) can hold precisely under the condition (Y11,...,Y1T0,Z1')lË†{(Y21,...,Y2T0,Z2'),.....,(Yi?11,.....,Yi?1T0,Zi'?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** **10**

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** **35**

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** **6**

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 16 We use a different length of the pre-tsunami period

to minimize the root mean squared prediction error (RMSPE) for **132**

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 Acehâ€™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** **36**

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.** **34**

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 **56**

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** **169**

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 **217**

deserves further attention in the future research. REFERENCES [1] C. Benson and E. Clay, â€œUnderstanding the economic and financial impact of natural disastersâ€. Washington D.C.: The World Bank, 2004. [2] J.C. Cuaresma, J. Hlouskova, and M. Obersteiner, â€œNatural disasters as creative destruction? Evidence from developing countries,â€ Econ. Inquiry, vol. 46, pp. 214-226, Apr. 2008. [3] S. Hallegatte, and P. Dumas, â€œCan natural disasters have positive consequences? Investigating the role of embodied technical change,â€ Ecological Econ., vol. 68, pp. 777-786, Jan. 2009. [4] I. Noy, â€œThe macroeconomic consequences of disasters,â€ J. Dev. Econ., vol. 88, pp. 221-231, Mar. 2009. [5] E. Strobl, â€œThe economic growth impact of natural disasters in developing countries: Evidence from hurricane strikes in the Central American and Caribbean regions,â€ J. Devel. Econ., vol. 97, pp. 131-140, Jan, 2012. [6] S. N. Durlauf, A. Kourtellos, and A. Minkin, â€œThe local Solow growth model,â€ Europ. Econ. Rev., vol. 45, no. 4â€“6, pp. 928â€“940, May 2001. [7] P.C. Athukorala, and B.P. Resosudarmo, â€œThe Indian Ocean Tsunami: Economic impact, disaster management, and lessons,â€ Asian Econ. Papers, vol. 4, no. 1, pp. 1- 39, Winter 2005. [8] World Bank and GFDRR, Indonesia: preliminary damage and loss assessment - The December 26, 2004 natural disaster. Washington, D.C.: The World Bank, 2005. [9] B. Nidhiprabha, â€œAdjustment and recovery in Thailand: Two years after the Tsunami,â€ unpublished. [10] A. Abadie, and

J. Gardeazabal, â€œThe economic costs of conflict: A case study of the Basque country,â€ Amer. Econ. Rev., vol. 93, no. 1, pp. 113â€“132, Mar. 2003. [11] A. Abadie, A. Diamond, and J. Hainmueller, â€œSynthetic control methods for comparative case studies: estimating the effect of Californiaâ€™s tobacco control programâ€, J. Am. Stat. Assoc., vol. 105, no. 490, pp. 493â€“505, June 2010. [12] W. duPont, and I. Noy, â€œWhat happened to Kobe? A reassessment of the impact of the 1995 earthquake in Japan,â€ to be published. 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). Credit to GDP ratio (%).Source: Bank of Thailand (BoT). It is the ratio of domestic credit provided by financial sector to provincial GDP. Inggrid is a lecturer and researcher in the Department of Business Management, Faculty of Economics, Petra Christian University, Indonesia. She did her postgraduate degree in economics at Uppsala University, Sweden. She is interested in program evaluation (with main focus on impact evaluation), poverty and inequality, human capital formation, and economic modeling. Siana Halim is a lecturer and researcher in the Department of Industrial Engineering, Faculty of Industrial Technology, Petra Christian University, Indonesia. She received her Ph.D. in statistics from Technische UniversitÃ¤t Kaiserslautern, Germany, in 2005. Her research interests are statistical modeling, data analysis, and non-parametric statistics. Indriati Njoto Bisono is a lecturer and researcher in the Department of Industrial Engineering, Faculty of Industrial Technology, Petra Christian University, Indonesia. She has been doing her Ph.D. in applied statistics at the University of Melbourne, Australia. Her teaching and research interest include Statistical Modeling and Design of Experiment. Lampiran F. Catatan Hasil Review dari Bulletin of Indonesia Economic Studies â€“ Decision on Manuscipt ID CBIE-2014-0004 Date: Sun, 15 Jun 2014 23:49:13 -0400 (EDT) From: pierre.vandereng@anu.edu.au Reply-To: pierre.vandereng@anu.edu.au Subject: Bulletin of Indonesian Economic Studies - Decision on Manuscript ID CBIE- 2014-0004 To: inggrid@peter.petra.ac.id Cc: pierre.vandereng@anu.edu.au, ben.wilson@anu.edu.au 15-Jun-2014 Dear Inggrid, I am writing to you with regard to manuscript CBIE-2014-0004 entitled 'How Resilient is the Economy to a Catastrophic Natural Disaster? Lessons from a Developing Country', which you submitted to the Bulletin of Indonesian Economic Studies (BIES). My apologies that it has taken so long to reach a decision on your paper. Sometimes it is difficult to find suitable referees. In addition, the journal relies on referees whocontribute their services voluntarily, and who sometimes cannot be rushed into submitting thier reports. You will find the criticisms of the two referees at the bottom of this this email. In light of their comments, I regret that I cannot offer to publish your paper in ourjournal. I agree with the general comments of both referees. Your paper discusses an potentially interesting topic. However, it is not well-positioned, it does not clearly explain thedata and the methodology it uses, and that the results do not fuly substantiate theconclusions that it draws. Thank you for considering BIES for the publication of your research. I hope the outcome of this specific submission will not discourage you from the submission of futuremanuscripts. Best regards, Pierre van der Eng Editor, Bulletin of Indonesian Economic Studies pierre.vandereng@anu.edu.au Referees' Comments to Author: Referee: 1 Comments to the Corresponding Author Summary The paper estimates the effects of the 2004 tsunami on regional GDP in the Indonesian province of Aceh. It applies annual data that is publicly available from the Indoneesian Central Bureau of Statistics (BPS). The identification strategy consists of the synthetic control method developed by Abadie and Gardeazabel (2003). The authors use the readily available SYNTH package that implemented the estimator in STATA. The paper deals with a topic that is very relevant of Indonesian policy makers. The 2004 Tsunami was one of the biggest exogenous shocks in the recent history of Indonesia. Sofar, most of the analysis of the effect of the events on economic welfare is at the microlevel. At the macro level, scholars have to rely on cross-country studies. The authorstry to fill this gap by providing an analysis at the provincial level. Considering the geographical extent of the Tsunami (only a few coastal areas were affected) and the lackof more disaggregated data (GDP data is only available at provincial level (N=26), usingthe synthetic control approach seems to be one of the few options to perform an empirical analysis at this level. Having said that,

the paper requires major revisions before it could be considered forpublication. Major comments: Discussion of the literature and contribution of the study: At this stage the literature review lacks structure and appears to be more like a list of abstracts. The authors tryto add some structure by dividing the literature along different growth models. However,I do not really see the connection to their own empirical analysis as they are not actually able to test the effect of a large-scale disaster in a Solow-Swan or endogenous growth model framework. I think it would be more sensible to structure the literaturesection as follows: First, shorten the review of the theoretical and most of the empirical studies. There you can highlight that up to the most recent studies usingcross-country data, evidence about the effects of natural disasters on growth was ambiguous. Second, discuss the cross-country studies that already show the differencesin the growth effects of disasters between developed and developing countries. Third,review existing empirical studies using regional GDP instead of national GDP and discuss why a more disaggregated analysis can be useful in this field and in particular in the context of developing studies. Fourth, outline the difficulties of estimating a regional growth model for developing countries (lack of data and lack of events (basically lack of variance on the right hand side). Fifth, discuss the studies that already apply the Abadie estimator in the context of natural disasters (e.g. Cavallo et al., Coffman and Noy). Ultimately, the manuscript just applies the same idea that those studies use to the 2004 Tsunami and its impact on Aceh. Related to the literature section, the authors should be more nuanced about their contribution. Whereby it is true that there is fairly limited evidence on the economics of disaster from developing countries, their study analysis a very particular event. The 2004 Tsunami was an extreme outlier in terms of fatalities and destruction. In addition, the application still has a case study character. One needs to be careful to make any general comments about developing economies? Vulnerability to natural disasters and how it compares to the vulnerability of developed countries. Data and Empirical Methodology: The authors should provide more detailed information about the sample and the data. Section 4 mentions 26 provinces (Aceh & 25 control provinces) However, then the numbers of the control provinces vary by figure between 19 and 23. In particular Table 2 which outlines the potential donor provinces for the synthetic counterfactual, there are only 23 listed. However, the empirical section talksabout 25 potential donor provinces. The authors should be very explicit about the sample that is used. If the sample differs between different types of analysis they should highlight why this is the case. The data should be described in more detail. For example in which units is Real GDP p.c. given (current? Constant? USD?). In table 1 it would behelpful to have the untransformed values of Real GDP, school enrollment etc. as opposed to the log-transformed values. In addition, it would be good to add the some of the postdisaster GDP values as well (i.e. 2005 and 2011). In Table 1, the sectoral shares do notadd up to 100%. Was there one or more sector excluded? If so, which one? If overnment expenditure makes up the rest than the values seem to be above 100%. Results: My biggest concern is regarding the actual results and the conclusions that are drawn from those results. First, the baseline results suggest that GDP p.c. in Aceh is about 25% lower in the years following the Tsunami as compared to the synthetic controlregion. This number seems to stem from the analysis presented in Figure 2. If I understand the reading correctly, the 25 % are basically the average Gap values per year post-2004. What is concerning is that the gap widens even more after the disaster and isaround 40% in 2010/2011. Can this be correct? A drop in regional GDP by such an extend over such a short period is highly unlikely. Just reporting GDP figures for ACEH, synthetic Aceh and the sample mean in Table 1 for some years post 2004 would be veryhelpful and probably prove me wrong. Figure 1 provides some illustration of the figures,but actual (untransformed numbers would be more helpful). The authors really need to make sure that these figures are solid and?robust? (as they argue on p. 5). In the abstract and to a minor extend in the results section, the authors claim that these effects are due to pro-cyclical fiscal behaviour and non-trivial inter-sectoral linkages. Although, I agree that these are potential explanations, their analysis does not allow to make a statement about the channels. They should definitely discuss potential channels but alsomake sure that the reader is not mislead in over-interpreting the results. As such they should remove this sentence from the abstract and add more discussion to the results and conclusion section. Minor comments: - The paper contains a large number of typos and grammatical mistakes. The next versionof the manuscript requires proper proof-reading. - On p. 2, 2nd paragraph, the authors argue that?[?] low- and middle-income economies have to incur larger burdens because these two groups typically experience more frequentand more destructive disasters than high-income countries? First, a strong statement like this one requires a reference. Second, the paper by Kahn (RESTat, 2005) presents descriptive statistics that low income countries do not experience more frequent natural disasters as high income countries. In addition, at least in monetary terms, disasters incur larger damages to developing countries (compare MunichRe stats). - Inverted U-shaped relationship between income and damages: The paper by Kellerberg and Mobarak (2008) shows that Indonesia is in?Region 1? which is an upward trend region inthe income/damage function. The authors could use that as additional motivation for their paper. In addition, there is another paper by Raschky (NHESS 2008) that shows this inverted U-shaped relationship but only for monetary losses and not for losses to humanlives. - There are a number of empirical papers presenting firm-level evidence about the intersectoral linkages and the effect of disasters on firm productivity. Referee: 2 Comments to the Corresponding Author General evaluation This paper deals with an interesting and relevant topic. It studies the Aceh tsunami to investigate the resilience of a region in a less-developed country. It applies thesynthetic control method (SCM) to come up with as clean as possible an estimate of theimpact of the tsunami on the regional economy. It performs an extensive robustness analysis to arrive at the conclusion that the negative (causal) impact of the Tsunami has been substantial. Despite my enthusiasm for the topic and also the employed methodology,I have several concerns regarding the current version of the paper on which I will elaborate in the remainder of my review. Main comments - The paper is rather poorly positioned in the literature. A recent paper in BIES (vol. 50, pp. 101-121) also deals with the

Tsunami, although using a different researchmethodology and focusing on population dynamics instead of GDP. Furthermore, theliterature following Davis and Weinstein's seminal paper on the impact of the nuclear bombs on Hirsohima and Nagasaki and the literatue that followed deserves more attention. - in interpreting the results, strong claims are made about the sectoral linkages and the procyclical fiscal behavior. For both explanations little sound empirical evidence isprovided. More efforts are needed to substantiate these conclusions, especially regarding the procyclical fiscal behavior. - some more focused effort in explaining why the impact of a natural disaster would differ between developed and developing countries would be welcome. - although SCM is appealing, I would welcome some further elaboration on the interpretation of the weights assigned to several of the regions. Related, I am somewhat concerned by the fact that looking at figure 1, it seems that - apart from the spike in 2001 - Aceh was already on a rather strong downward trend. This casts doubt on whether sufficient weight is given to trends (as opposed to levels) in selecting the weights for the different regions composing the control group. More explanation, elaboration andsensitivity analysis would be welcome on this point. My concerns are further strengthened by the low investment rate as evidenced in Table 1 (and also the atypical size of theagricultural and manufacturing sector). Minor comments - the review in section 2 can be substantially shortened and focused. - it is not clear to what extent regional deflators are used in constructing real GDP. - The paper needs a thorough linguistic check because it contains many typos and stylistic mistakes. Lampiran G. Formulir Evaluasi atas Capaian Luaran FORMULIR EVALUASI ATAS CAPAIAN LUARAN KEGIATAN Ketua : Dr. Siana Halim, S.Si, M.Sc.Nat Perguruan Tinggi : Universitas Kristen Petra â€“ Surabaya Judul : Evaluasi Dampak Bencana Tsunama 2004 terhadap Kinerja Perekonomian Provinsi Aceh: Aplikasi Synthetic Control Methods Waktu Kegiatan : Tahun ke 2 dari rencana 2 tahun Luaran yang direncanakan dan capaian yang tertulis dari proposal awal No. Luaran yang direncanakan Capaian 1. Mengikuti International Conference on Statistics and Mathematics Modeling 2014 Accepted 2 Mengikuti The 5th International Conferences on Aceh and Indian Ocean Studies, Banda Aceh, 17-18 Novmber 2014 Accepted 3. Publikasi di Jurnal International Revisi ulang untuk masuk ke jurnal yang lain 4 Publikasi di Jurnal International on Applied Mathematics and Statistics Submitted CAPAIAN 1. Publikasi Ilmiah Keterangan Artikel Jurnal ke-1 Nama jurnal yang dituju Bulletin of Indonesian Economic Studies (BIES) Klasifikasi Jurnal Jurnal International Impact Factor jurnal 1.33 Judul Artikel How Resilient is the Economy to A Catastrophic Natural Disaster? Lessons Learned from A Developing Country Status Naskah Ditolak Artikel Jurnal ke-2 Nama jurnal yang dituju International on Applied Mathematics and Statistics Klasifikasi Jurnal Jurnal International Judul Artikel Examining Spatial Effects of Regional Income Convergence in Sumatra Island Status Naskah Accepted 2. PEMBICARA PADA PERTEMUAN ILMIAH Nasional International Judul Makalah Examining Spatial Effects of Regional Income Convergence in Sumatra Island Nama Pertemuan Ilmiah International Conference on Statistics and Mathematics Tempat Pelaksanaan Hotel Majapahit Surabaya Waktu Pelaksanaan 27-28November 2014 - Draft makalah - Sudah dikirim - Sedang direview x - Sudah dilaksanakan akan dilaksanakan Judul Makalah Assessing the Impact of the Indian Ocean Tsunami on the Economy: Evidence from Indonesia and Thailand Nama Pertemuan Ilmiah The 5th International Conferences on Aceh and Indian Ocean Studies Tempat Pelaksanaan Banda Aceh Waktu Pelaksanaan 17-18 November 2014 -Draft makalah -Sudah dikirim - Sedang direview x -Sudah dilaksanakan Akan dilaksankan Catatan: Luaran submit di Bulletin of Indonesian Studi ditolak, dan akan direvisi ulang sesuai dengan saran dari para reviewer untuk di-submit ke jurnal lain. Hasil review ada pada Lampiran 2. Surabaya, 1 November 2014 Ketua Dr. Siana Halim, S.Si, M.Sc Lampiran H1. Biodata Ketua Peneliti A. Identitas Diri 1. Nama Lengkap Dr. Siana Halim, S.Si.,M.Sc.nat 2. Jabatan Fungsional S3/Lektor Kepala 3. Jabatan Struktural Ka.Bid. Sistem Kualitas Jurusan Teknik Industri 4. NIP/NIK 94-032 5. NIDN 0709117001 6. Tempat & Tanggal Lahir Madiun, 9 November 1970 7. Alamat Rumah Rungkut Mapan Barat XII/AK.10 Surabaya 8. Nomor Telepon/Faks/HP 031-8714530/-/081335799933 9. Alamat Kantor Jl. Siwalankerto 121-131, Surabaya 60236 10. Nomor Telepon/Faks 031-2983425/031-8436418 11. Alamat e-mail halim@peter.petra.ac.id 12. Lulusan yang telah dihasilkan 100 13. Mata kuliah yang diampu 1. Teori Probabilitas 2. Statistika Industri 3. Teknik Peramalan (Forecasting) 4. Teknik Keandalan (Realibility) B. Riwayat Pendidikan S-1 S-2 S-3 Nama Perguruan Tinggi Institut Teknologi Sepuluh Nopember Surabaya Technische Universitaet Kaiserslautern, Kaiserslautern, Germany Technische Universitaet Kaiserslautern, Kaiserslautern, Germany Bidang Ilmu Matematika Industrial Mathematics Statistics Tahun Masuk- Lulus 1989-1993 1996- 1998 2001-2005 Judul Skripsi/Thesis/ Disertasi Analisa kompleksitas pada algoritma searching Invers Rainflow Matrix Spatially adaptive detection of local disturbances in time series and stochastic processes on the integer lattice Z2 Nama Pembimbing/P romotor Drs.Bandung Arry Sanjoyo, MI.Komp Prof. Dr. Juergen Franke Prof. Dr. Juergen Franke C. Pengalaman Penelitian Dalam 5 Tahun Terakhir No Tahun Jabatan Pendanaan Sumber Jml (Juta Rp) 1. 2011 Guest Researcher, Sophia University- Tokyo-Japan Sophia University- Tokyo 100 2. 2008- 2011 Researcher, NFS-Asia- Singapore NFS-Asia 200 3. 2008- 2009 Guest Researcher, Fraunhofer â€“ IPK- Berlin â€“Germany DAAD- Fraunhofer- Germany 265 D. Pengalaman Pengabdian Kepada Masyarakat Dalam 5 Tahun terakhir No Tahun Judul Pengabdian Kepada Masyarakat Pendanaan Sumber Jml (Juta Rp) 1. 2012 Training statistics untuk guru-guru SD Petra 1 2. 2011 Training statistics untuk guru-guru SD Petra 1 E. Pengalaman Penulisan Jurnal Dalam 5 Tahun Terakhir No Judul Artikel Volume/ Nomor/ Tahun Nama Jurnal 1. Credit Scoring Modeling Vol. 16, No. 1 pp. 17-24, 2014 Jurnal Teknik Industri (Terakreditasi) 2. The Effect of Operation 24 Hours on Reducing Collision in the City of Edmonton Vol. 58, pp. 106-114, 2013 Accident Analysis and Prevention (Science Direct) 3. Deteksi Keausan Alat pada Proses Pengeboran Sumber Alam Vol. 14, No.2, pp. 123-28, 2012 Jurnal Teknik Industri (Terakreditasi) 4. Pemodelan Time Series Multivariat secara Automatic Vol. 13, No. 1, pp. 19-26m 2011 Jurnal Teknik Industri (Terakreditasi) 5. Statistical Analysis for the Intellectual Capital Statement Vol. 11, No. 1, 2010 Journal of Intellectual Capital (Emeralrd) 6. Automatic Seasonal Auto Regressive Moving Average Models and Unit Root Test Detection

Vo.3, No. 4, 2008 International Journal of Management Science and Engi- neering Management (Taylor & Francis) 7. Penentuan Harga Jual Hunian pada Metode Regresi Spasial Vol. 10, No. 2, 2008 Jurnal Teknik Industri (Terakreditasi) F. Pengalaman Penyampaian Makalah Secara Oral Pada Pertemuan/ Seminar Ilmiah Dalam 5 Tahun terakhir No Judul Artikel Nama Pertemuan/Seminar Ilmiah Tempat dan Waktu 1. The Synthetic Regression Methods: How the Indian Ocean Tsunami Affects Growth Trajectories International Conference on Applied Statistics Bandung, 16-18 Sep 2013 2. Garbage Trucsâ€™ Routing in Surabaya The 3rd International Forum and Conference on Logistic and Supply Chain Management Bali, 27-29 Juli 2013 3. Defect Detection on Texture using Nonparametric Regression 8th World Congress in Probability and Statistics Istanbul, 9-14 Juli 2012 4. Production Inventory Model for Deteriorating Items with Common Distribution Machine Unavailability The 2th International Forum and Conference on Logistic and Supply Chain Management Taipeh, 11-12 mei 2012 5. Parameter Estimation of Space-Time Model Using Genetic Algorithm The IEEE International conference on Industrial Engineering and Engineering Management Hongkong 8-11 Dec 2009 6. Stochastic Judgments in the AHP: Confidence Interval Construction using Score Statisticsâ€œ The 9th Asia Pacific Industrial Engineering and Management Systems Conference 2008 Bali - Indonesia, 3rd â€“ 5rd December, 2008 G. Pengalaman Penulisan Buku Dalam 5 Tahun Terakhir No Judul Buku Tahun Jumlah Halaman Penerbit 1. "Structural Adaptive Smoothing Procedures" in: Mathematical Methods in Signal Processing and Digital Image, eds. R. Dahlhaus, J. Kurths, P. MaaÃŸ and J. Timmer, 2008 46 Springer, Berlin- Heidelberg-New York H. Pengalaman Perolehan HKI Dalam 5-10 Tahun Terakhir No Judul/Tema HKI Tahun Jenis Nomor P/ID - - - - I. Pengalaman Merumuskan Kebijakan Publik/Rekayasa Sosial Lainnya Dalam 5 Tahun Terakhir No Judul/Tema/Jenis Rekayasa Sosial Lainnya yang Telah Diterapkan Tahun Tempat Penerapan Respon Masyarakat - - - - J. Penghargaan yang Pernah Diraih dalam 10 tahun terakhir (dari pemerintah, asosiasi, atau institusi lainnya) No Jenis Penghargaan Institusi Pemberi Penghargaan Tahun 1 Fraunhofer Technopreneur Award Fraunhofer Institute Indonesia 2008 2 Sophia University-Lecturing and Research Grant Sophia University-Tokyo 2011 Semua data yang saya isikan dan tercantum dalam biodata ini adalah benar dan dapat dipertanggungjawabkan secara hukum. Apabila di kemudian hari ternyata dijumpai ketidak-sesuaian dengan kenyataan, saya sanggup menerima risikonya. Demikian biodata ini saya buat dengan sebenarnya untuk memenuhi salah satu persyaratan dalam pengajuan Penelitian Hibah Bersaing. Surabaya, 1 November 2014 Ketua Peneliti Dr. Siana Halim, S.Si.,M.Sc.nat Lampiran H2. Format Biodata Anggota Peneliti A. Identitas Diri 1. Nama Lengkap Inggrid, SE.,M.A.,M.Sc 2. Jabatan Fungsional S2/Asisten Ahli 3. Jabatan Struktural - 4. NIP/NIK 04-033 5. NIDN 0717108001 6. Tempat & Tanggal Lahir Malang, 17 Oktober 1980 7. Alamat Rumah Jl. Siwalankerto III/8, Surabaya 60236 8. Nomor Telepon/Faks/HP 08125274297 9. Alamat Kantor Jl. Siwalankerto 121-131, Surabaya 60236 10. Nomor Telepon/Faks 031-2983246/031-8476024 11. Alamat e-mail inggrid@peter.petra.ac.id 12. Lulusan yang telah dihasilkan 9 mahasiswa 13. Mata kuliah yang diampu 1. Ekonomi Makro 2. Ekonomi Mikro 3. Teori Ekonomi 4. Pemodelan Bisnis B. Riwayat Pendidikan S-1 S-2 S-2 Nama Perguruan Tinggi Universitas Brawijaya University of Antwerp, Belgia Uppsala University, Swedia Bidang Ilmu Ilmu Ekonomi Globalization and Development Economics Tahun Masuk- Lulus 1999-2003 2007-2008 2009-2011 Judul Skripsi/Thesis/D isertasi Model Simultan dari Nilai Tukar, Utang Luar Negeri, Harga Minyak, dan Variabel-Variabel Makroekonomi Lain (Studi Kasus: Indonesia) Wage Inequality and Fragmentation: the impact of Trade Liberalization in Indonesia Can A Social Health Insurance Program Protect Household Consumption When Exposed to Health Shocks? a Case with Supply- Side Constraints Nama Pembimbing/P romotor Prof. Dr. Munawar Ismail, S.E., DEA Prof. Dr. German Calfat, M.Sc. Niklas Bengtsson, P.hD C. Pengalaman Penelitian Dalam 5 Tahun Terakhir No Tahun Judul Penelitian Pendanaan Sumber Jml (Juta Rp) 1. 2008 Identifying Winners and Losers from International Fragmentation: Evidence from Indonesia University of Antwerp 75 D. Pengalaman Pengabdian Kepada Masyarakat Dalam 5 Tahun terakhir No Tahun Judul Pengabdian Kepada Masyarakat Pendanaan Sumber Jml (Juta Rp) - - - - E. Pengalaman Penulisan Artikel Ilmiah Dalam Jurnal Dalam 5 Tahun Terakhir No Judul Artikel Volume/ Nomor/ Tahun Nama Jurnal - - - F. Pengalaman Penyampaian Makalah Secara Oral Pada Pertemuan/Seminar Ilmiah Dalam 5 Tahun terakhir No Nama Pertemuan Ilmiah/Seminar Judul Artikel Waktu Tempat dan - - - G. Pengalaman Penulisan Buku Dalam 5 Tahun Terakhir No Judul Buku Tahun Jumlah Halaman Penerbit - - - - H. Pengalaman Perolehan HKI Dalam 5-10 Tahun Terakhir No Judul/Tema HKI Tahun Jenis Nomor P/ID - - - - I. Pengalaman Merumuskan Kebijakan Publik/Rekayasa Sosial Lainnya Dalam 5 Tahun Terakhi No Judul/Tema/Jenis Rekayasa Sosial Lainnya yang Telah Diterapkan Tahun Tempat Penerapan Respon Masyarakat - - - - J. Penghargaan yang Pernah Diraih Dalam 10 tahun terakhir (dari pemerintah, asosiasi, atau institusi lainnya) No Jenis Penghargaan Institusi Penghargaan Pemberi Tahun - - - Semua data yang saya isikan dan tercantum dalam biodata ini adalah benar dan dapat dipertanggungjawabkan secara hukum. Apabila di kemudian hari ternyata dijumpai ketidak-sesuaian dengan kenyataan, saya sanggup menerima resikonya. Demikian biodata ini saya buat dengan sebenarnya untuk memenuhi salah satu persyaratan dalam pengajuan Penelitian Hibah Bersaing. Surabaya, 1 November 2014 Anggota Peneliti Inggrid, SE.,M.A.M.Sc Lampiran H3. Format Biodata Anggota Peneliti A. Identitas Diri 1. Nama Lengkap Dra. Indriati Njoto Bisono, M.Sc 2. Jabatan Fungsional S2/Lektor 3. Jabatan Struktural Dosen Jurusan Teknik Industri 4. NIP/NIK 98-040 5. NIDN 0706026501 6. Tempat & Tanggal Lahir Banyuwangi, 6 Pebruari 1965 7. Alamat Rumah Puri Mas, Jl. Pecatu III E15/3, Surabaya 8. Nomor Telepon/Faks/HP 031-8721204/-/082131345435 9. Alamat Kantor Jl. Siwalankerto 121-131, Surabaya 60236 10. Nomor Telepon/Faks 031-2983425/031-8436418 11. Alamat e-mail mlindri@peter.petra.ac.id 12. Lulusan yang telah dihasilkan 50 13. Mata kuliah yang diampu 5. Teori Probabilitas 6. Statistika Industri 7. Perancangan Eksperimen Statistika B. Riwayat Pendidikan S-1 S-2 S-3 (candidate) Nama Perguruan Tinggi Institut Teknologi Sepuluh Nopember Surabaya Monash University, Melbourne, Australia The University of Melbourne, Australia Bidang Ilmu Matematika Applied Statistics Applied Statistics Tahun Masuk- Lulus

1984-1988 2004 - 2006 2009-sekarang Judul Skripsi/Thesis/ Disertasi Metode Elemen Hingga dan Aplikasinya pada Elastisitas Comparison of Tests of Non-nested Hypotheses with Application to Phenology On Modelling Spatial Extremes Nama Pembimbing/P romotor Drs. Soeharjo, Prof. Ir. Benjamin Lumantarna, M.Sc. Dr. Malcolm Clark Dr. Andrew Robinson C. Pengalaman Penelitian Dalam 5 Tahun Terakhir No Tahun Jabatan Pendanaan Sumber Jml (Juta Rp) 1. 2012 Visitor NCAR Maurice Belz Trust 50 25 D. Pengalaman Pengabdian Kepada Masyarakat Dalam 5 Tahun terakhir No Tahun Judul Pengabdian Kepada Masya- rakat Pendanaan Sumber Jml (Juta Rp) 1. 2009 Training Excel untuk guru-guru SD Siwalankerto Petra 1 Pengalaman Penulisan Jurnal Dalam 5 Tahun Terakhir No Judul Artikel Volume/ Nomor/ Tahun Nama Jurnal 1. Mengenal data ekstrim dan distribusinya Vol.13 No.2, 2011 Jurnal Teknik Industri 2 Nonparametric Mean in the Interval Judgments on the Analytic Hierarchy Process (AHP) Vol. 3 No.1, 2007 International Journal of Information Systems for Logistics and Management (IJISLM) 3. Regression Analysis of Productivity using Mixed Effect Model Vol. 9, No. 2, 2007 Jurnal Teknik Industri 4. Perbaikan Sistem Divisi Pengolahan dan Pengadaan Perpustakaan UK. Petra dengan Filosofi Lean Six Sigma Vol. 9, No. 1, 2007 Jurnal Teknik Industri E. Pengalaman Penyampaian Makalah Secara Oral Pada Pertemuan/ Seminar Ilmiah Dalam 5 Tahun terakhir No Judul Artikel Nama Pertemuan/Seminar Ilmiah Tempat dan Waktu 1. Bayesian spatial hierarchical modeling for temperature extremes Bayes on the Beach Cairn, October 2011 2. Stochastic Judg- ments in the AHP: Confidence Interval Construction using Score Statisticsâ€œ The 9th Asia Pacific Industrial Engineering and Management Systems Conference 2008 Bali â€“ Indone- sia, 3rd â€“ 5rd December, 2008 3. Automatic Seasonal Auto Regressive Moving Average The IEEE International conference on Industrial Engineering and Engineering Management Singapore 3-5 Dec 2007 Models and Unit Root Test Detection F. Pengalaman Penulisan Buku Dalam 5 Tahun Terakhir No Judul Buku Tahun Jumlah Halaman Penerbit - - - - G. Pengalaman Perolehan HKI Dalam 5-10 Tahun Terakhir No Judul/Tema HKI Tahun Jenis Nomor P/ID - - - - H. Pengalaman Merumuskan Kebijakan Publik/Rekayasa Sosial Lainnya Dalam 5 Tahun Terakhir No Judul/Tema/Jenis Rekayasa Sosial Lainnya yang Telah Diterapkan Tahun Tempat Penerapan Respon Masyarakat - - - - I. Penghargaan yang Pernah Diraih dalam 10 tahun terakhir (dari pemerintah, asosiasi, atau institusi lainnya) No Jenis Penghargaan Institusi Pemberi Peng- hargaan Tahun 1 Beasiswa untuk S3 Dikti 2009 2 Beasiswa untuk S2 ADS 2004 Surabaya, 1 November 2014 Anggota Peneliti Dra. Indriati Njoto Bisono, M.Sc 1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 *** * *** *** *** *** *** *** *** * *** ** *** *** *** *** *** *** *** *** *** *** *** *** *** * *** *** *** *** *** ** *** *** *** *** *** ** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***