Fly across the boundary

A tracing of actual movements in air transportation network

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Problematic

- Flow is more prominet at the border.

- The border, above all, provides an opportunity to observe the spatial dynamics (or interaction) between the regions brought by the flows.

- Boundary defined by specific zoning does not always correspond to the structure of flow.

- Thus, boundary is crucial in flow statistics, but mostly remains conventional and unchallenged in many aspects, because boundary is hardly modified in order to maintain statistical stability.

Simple questioning follows.

If we can acquire the information of the flow only at the boudary,

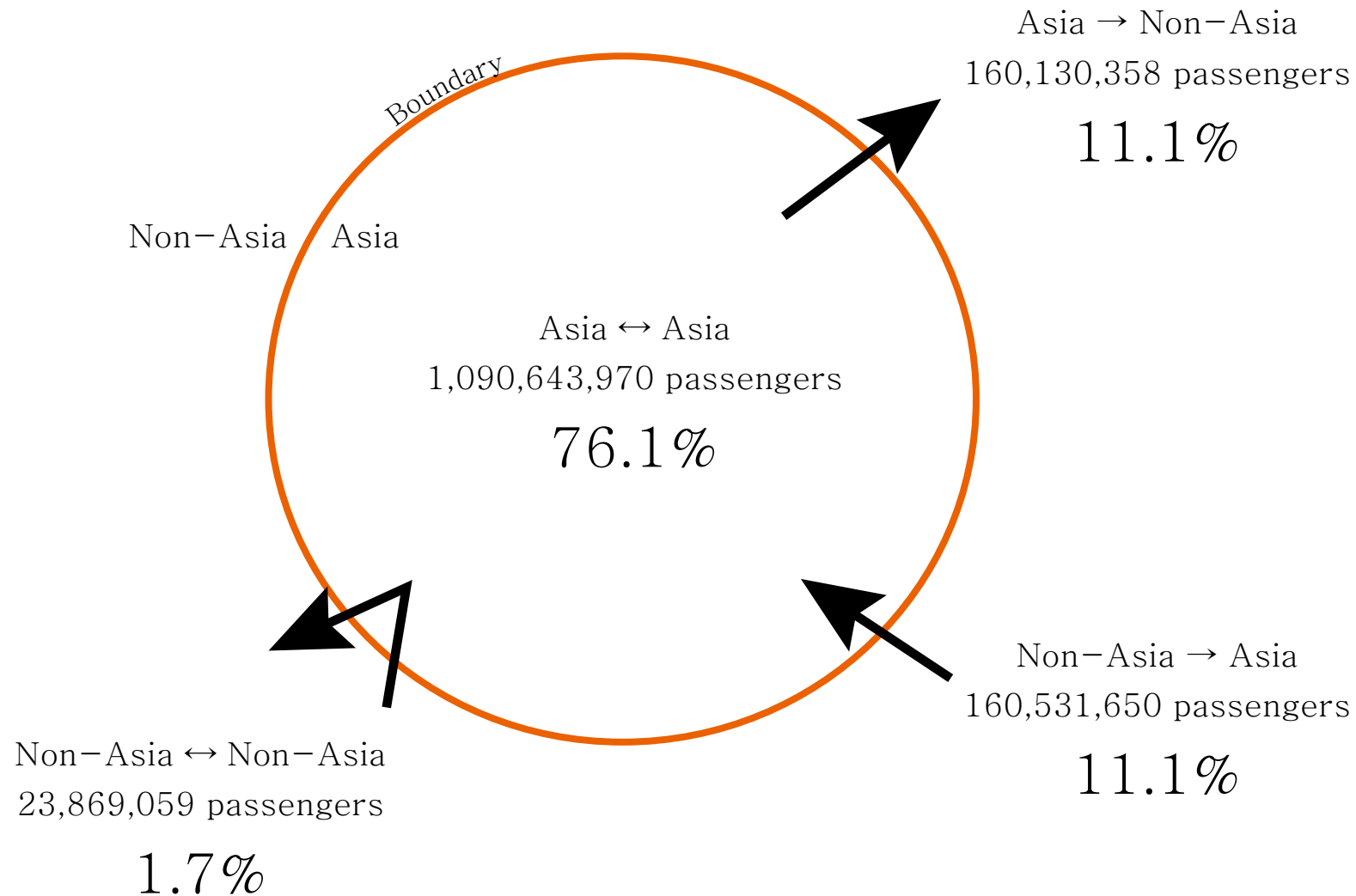how are the actual flow to be imagined?

Air Transportation Network

Statistics are well-established in air transport network including exact information on origin-destination and the paths via transfer airports.

By comparing the traffic across the boundary with the actual routes, we can examine the implication of the flow statistics on the border.

We use the data of air passengers derived from OAG's traffic Analyser for convenience, that is not based on exact number of ticketing, but booking numbers.

- OAG Booking Data (2011~2015, monthly)

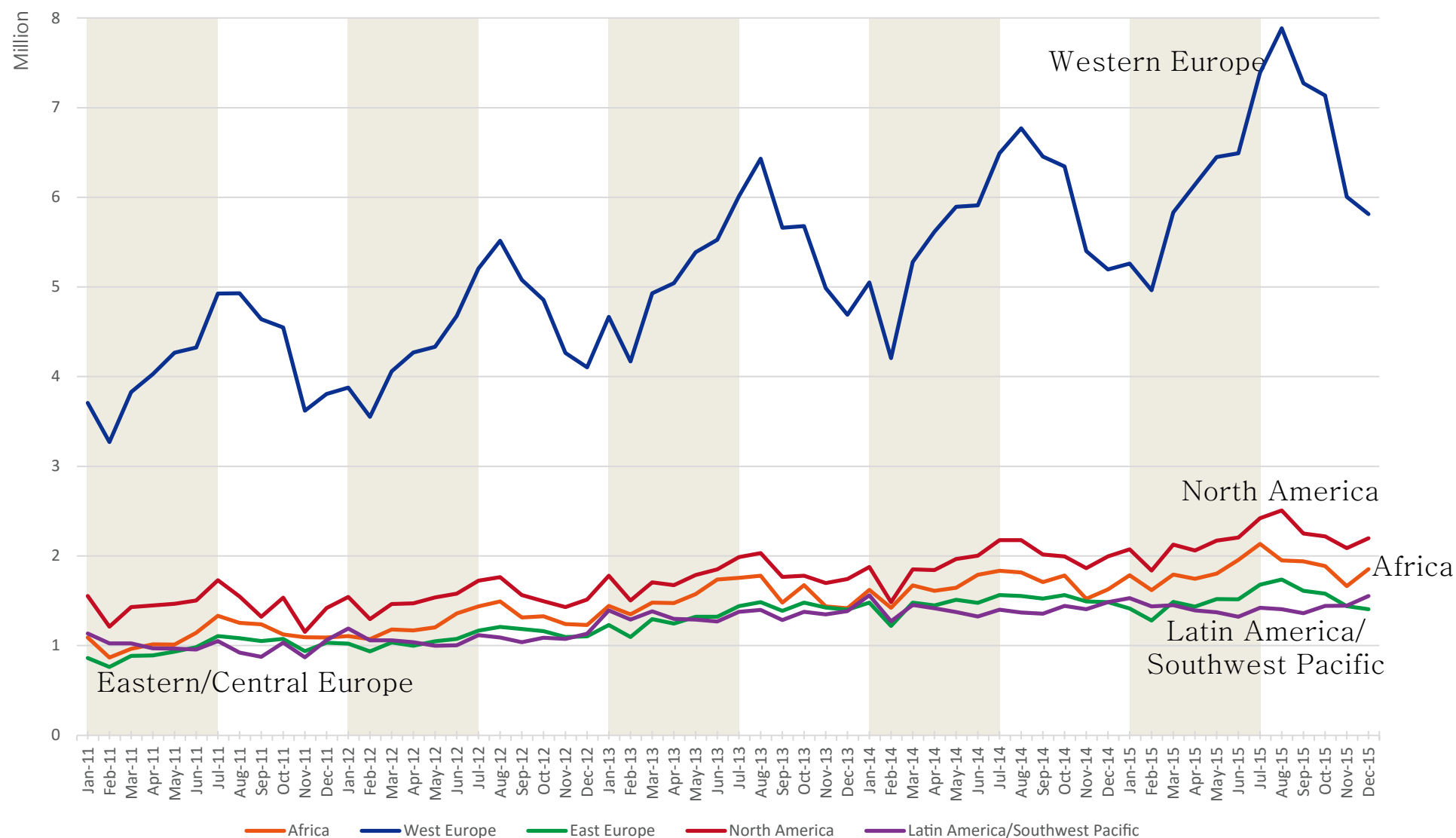- All the trips from and to Asia including the trips inside Asia.

Overview

Asia → Non-Asia
160,130,358 passengers
11.1%

Boundary

Non-Asia | Asia

Asia ↔ Asia
1,090,643,970 passengers
76.1%

Non-Asia → Asia
160,531,650 passengers
11.1%

Non-Asia ↔ Non-Asia
23,869,059 passengers
1.7%

Air transportation data
(OAG Booking Data, 2015)

Air passenger traffic in Asia

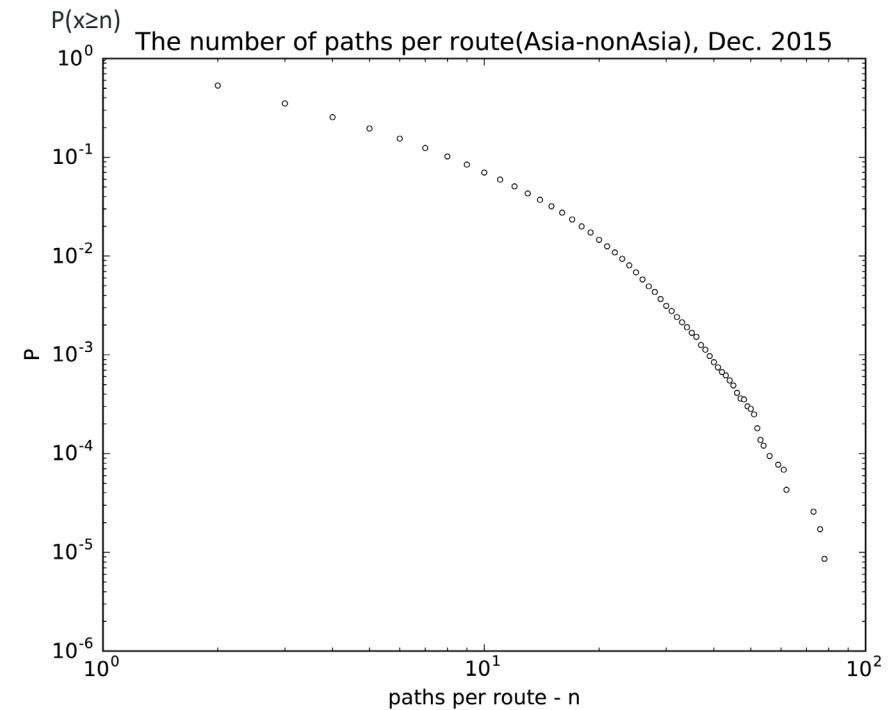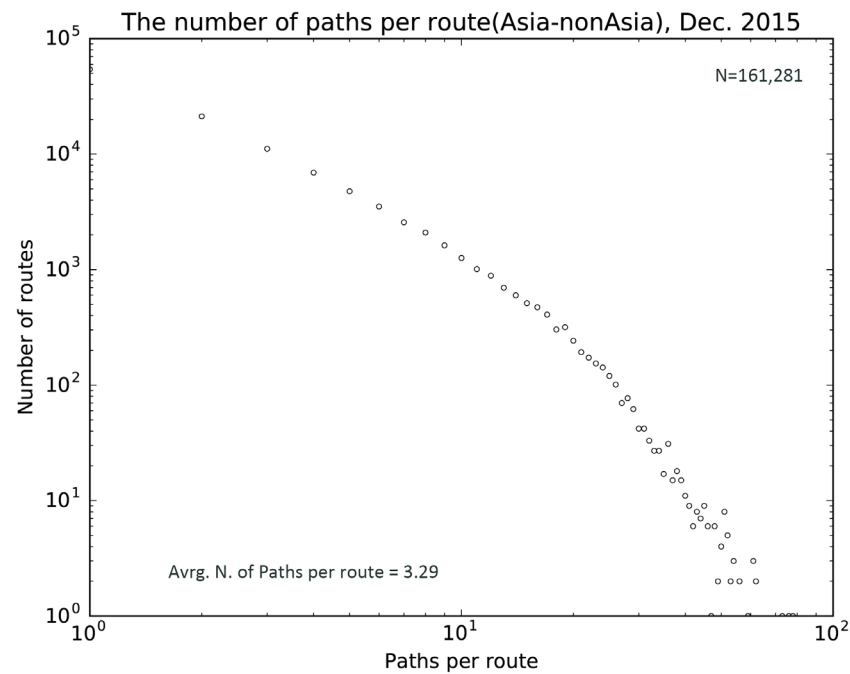|	2011	2012	2013	2014	2015	Growth
Asia→Asia	724,917,264	782,773,949	914,128,835	1,006,269,367	1,096,643,970	1.51
Asia→Non−Asia	103,907,455	113,203,179	135,272,195	146,538,485	160,130,358	1.54
Non−Asia→Asia	102,148,632	110,860,278	135,486,445	146,464,432	160,531,650	1.57
Non−Asia→Non−Asia	9,440,334	12,104,927	18,486,172	20,453,794	23,869,059	2.53
Total	940,413,685	1,018,942,333	1,203,373,647	1,319,726,078	1,441,175,037	1.53

Number of passengers from Asia to Non-Asia
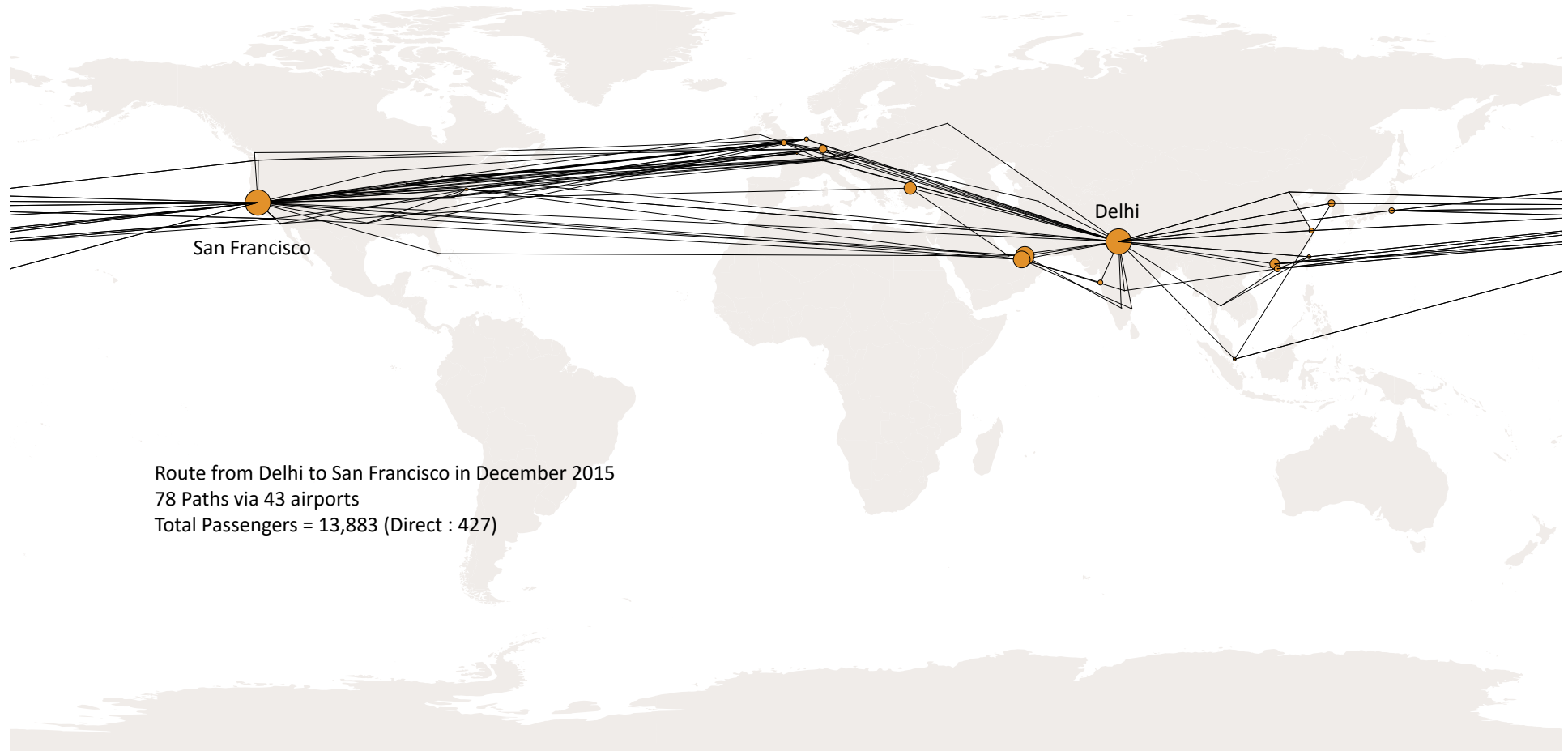
Number of passengers from and to Asia

Western Europe

Eastern/Central Europe

Passengers 2015（thousand）

Routes December 2015
(From Asia / To Asia)

35,192

147,235

58,132

North America

7,064/7,145

17,623/18,119

17,864/17,635

ASIA

850/892

708 Latin America : Caribbean

North Africa

1,850/1,750

1,041/1,102

841 Latin America : Central America

27,465

576/678

601 Latin America : Upper South America

1,251/1,337

4,728/4,261

2,888 Latin America :Lower South America

1,727/1,681

Eastern Africa

6,896

1,723/1,792

31,162

1,877/1,760

Central/western Africa

4,830

Southwest Pacific

4,710

Southern Africa

December 2015

Number of paths per route from Asia to Non−Asia

The number of paths per route(Asia-nonAsia), Dec. 2015

N=161,281

Avrg. N. of Paths per route = 3.29

The number of paths per route(Asia-nonAsia), Dec. 2015

December 2015

Maximum paths per route from Asia to Non−Asia

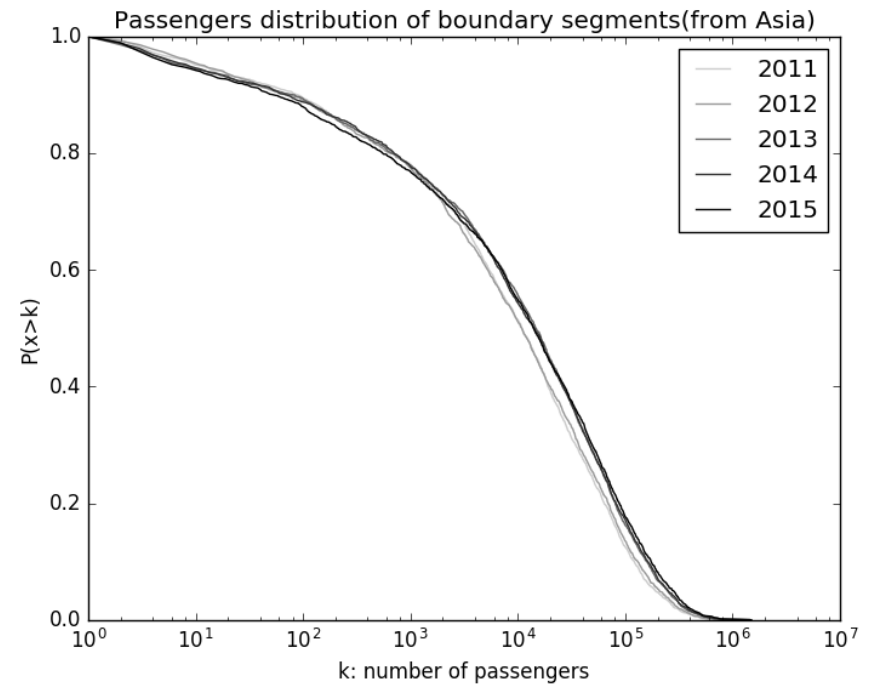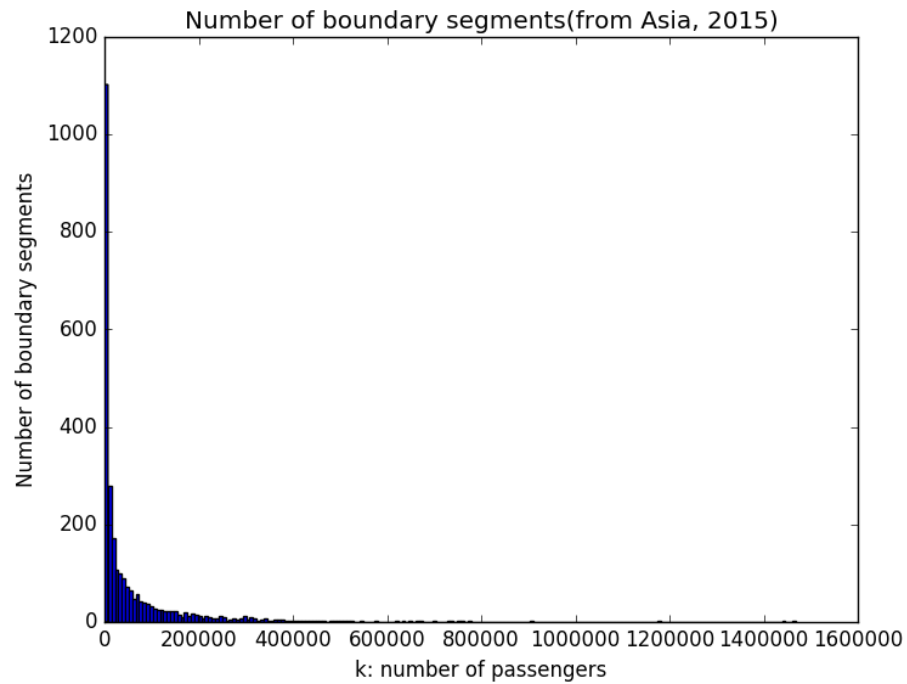78 paths via 43 airports from Delhi to San Francisco

Delhi

San Francisco

Route from Delhi to San Francisco in December 2015
78 Paths via 43 airports
Total Passengers = 13,883 (Direct : 427)

December 2015

Segment distribution of routes across the Asian Boundary

Nodes (Airports)

N2   1,246

832

3,589   3,465

Non-Asia

5,500   N1   307

Boundary Segment

1,876   1,925

A1   156

Aisa

2,702

1,435   1,506

A2   479

226

December 2015
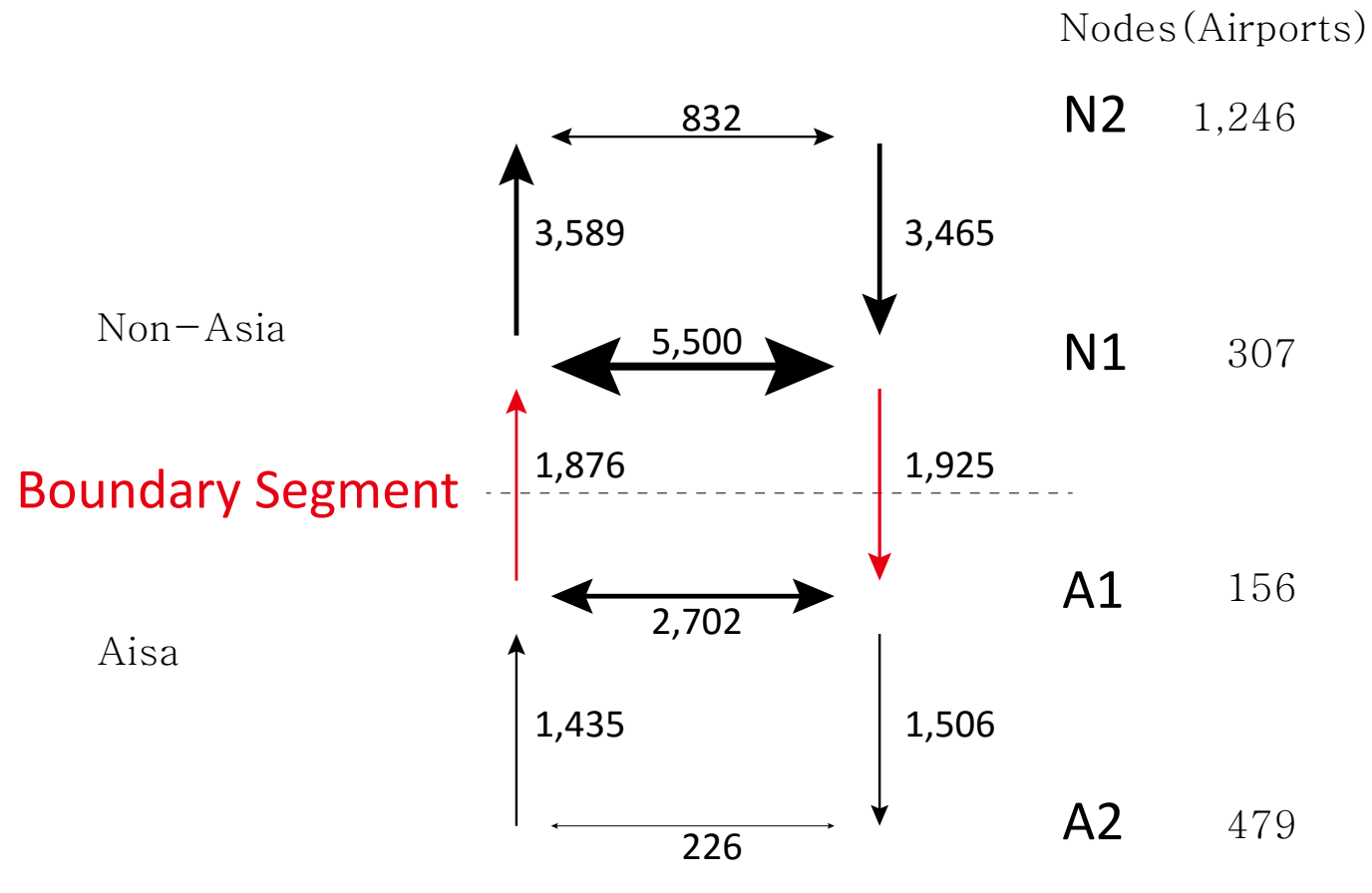
Passenger distribution by BS

Number of boundary segments(from Asia, 2015)

Passengers distribution of boundary segments(from Asia)

Largest number of passengers in a BS from Asia

Routes through the boundary segment from Cairo to Jeddah

Cairo

Jeddah

137,230 in December 2015

92,847 Direct trips
2,239 Via
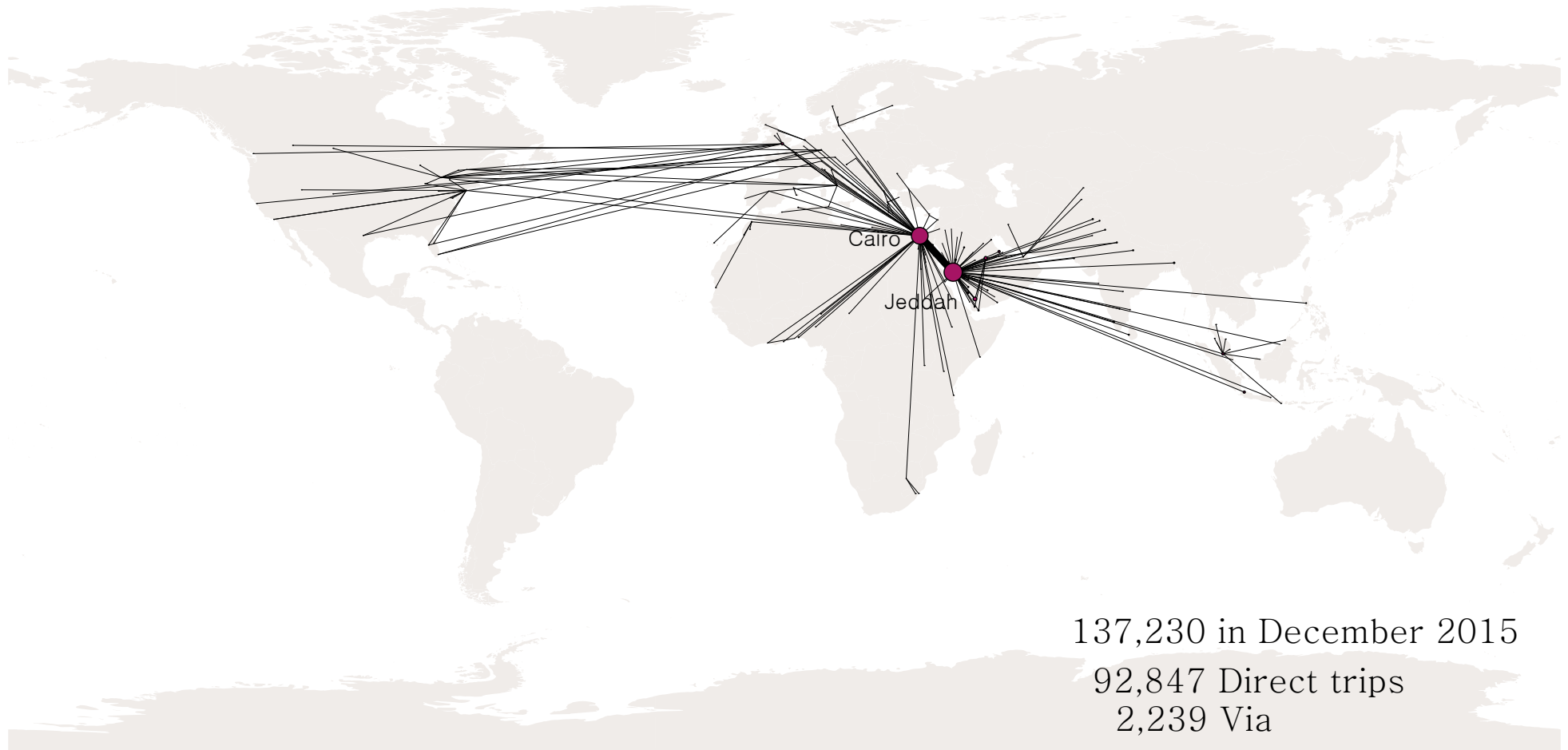
Boundary Segments vs. Actual Paths (O−D)

Boundary Segments
December 2015

Western Europe

Eastern/Central Europe

North Africa

North America

Latin America:
Caribbean

Asia

Latin America:
Central America

Eastern Africa

Latin America:
Upper South America

Central/Western Africa

Latin America:
Lower South America

Southern Africa

Southwest Pacific

Routes (Asia−nonAsia)
December 2015

Eastern/Central Europe

Western Europe

North America

North Africa

Latin America:
Caribbean

Eastern Africa

Latin America:
Central America

Asia

Latin America:
Upper South America

Central/Western Africa

Latin America:
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Southern Africa

Southwest Pacific

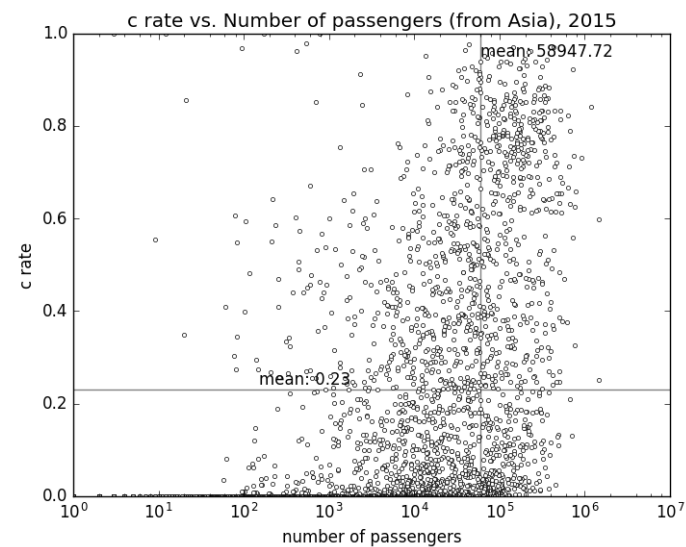# Trip composition of Boundary Segment
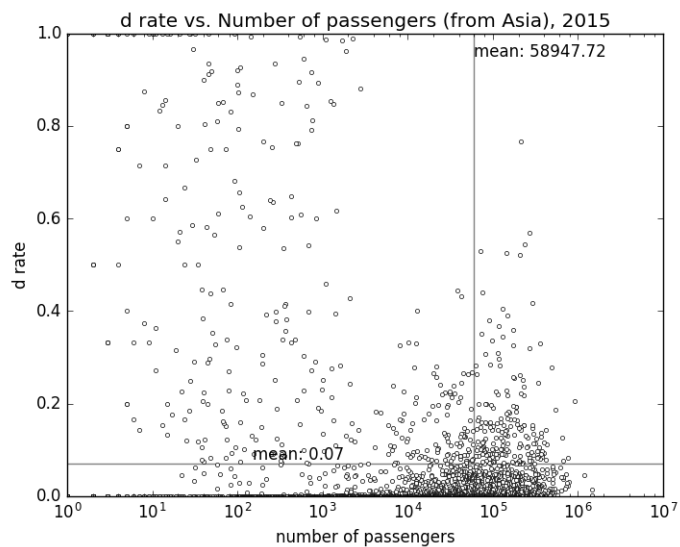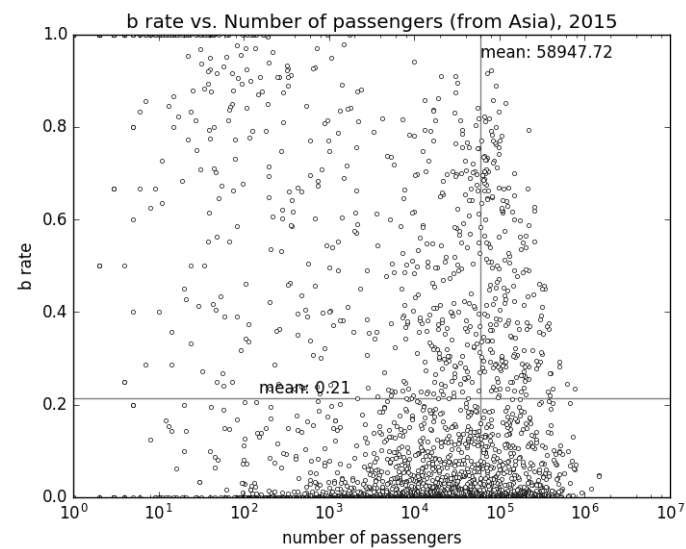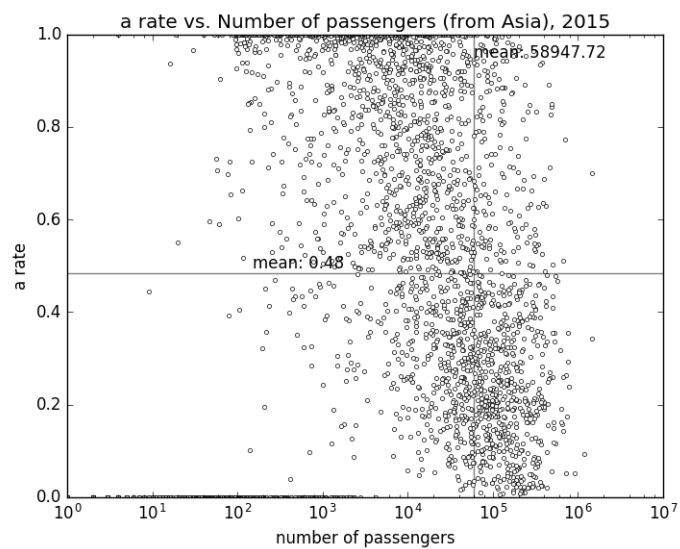
Boundary
Segments

O

D

Border

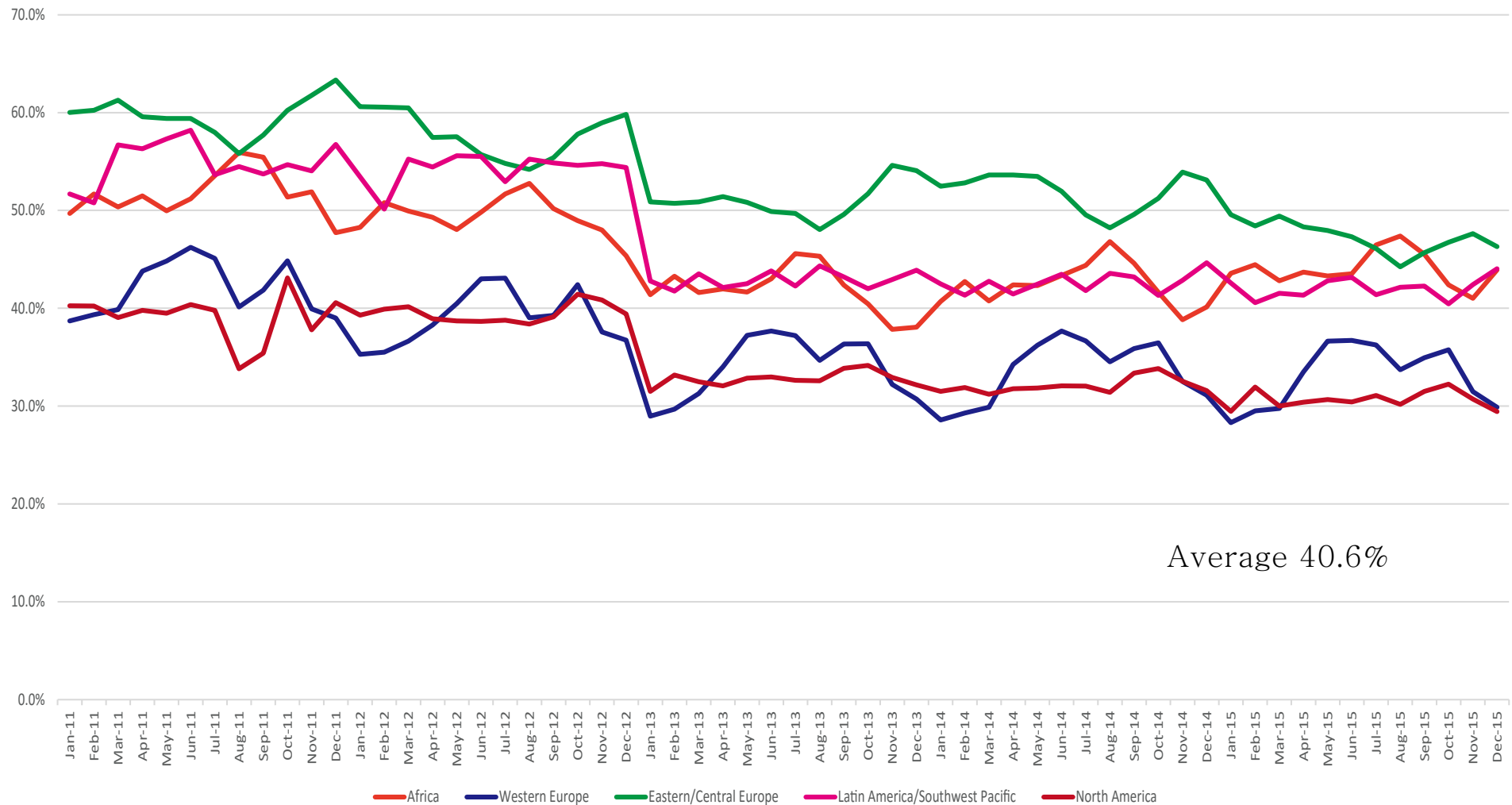a : direct trip between boundary nodes across the border

b : trip only from a boundary node across the border

c : trip only arriving to a boundary node across the border

d : trip through boundary nodes across the border

a rate vs. Number of passengers (from Asia), 2015

mean: 58947.72

mean: 0.48

b rate vs. Number of passengers (from Asia), 2015

mean: 58947.72

mean: 0.21

d rate vs. Number of passengers (from Asia), 2015

mean: 58947.72

mean: 0.07

c rate vs. Number of passengers (from Asia), 2015

mean: 58947.72

mean: 0.23

A : rate of direct trips in Boundary Segments from Asia

Average 40.6%

Africa   Western Europe   Eastern/Central Europe   Latin America/Southwest Pacific   North America

Insights

- Various distributions, such as the number of paths per route, the number of passengers paths, etc, follow skewed distribution, as expected by most of previous network analysis literatures.

- The amount of movements might not be very significant. In the boundary segments, the number of passengers that a segment carries has little relevancy for the each rate of passengers.

- There is asymmetry between the nodes, seen with rate B and C. We must consider the different perspectives that the regions have in confronting the flow.

- The movements in the boundary segments imply the relation of two regions in different ways.

And...

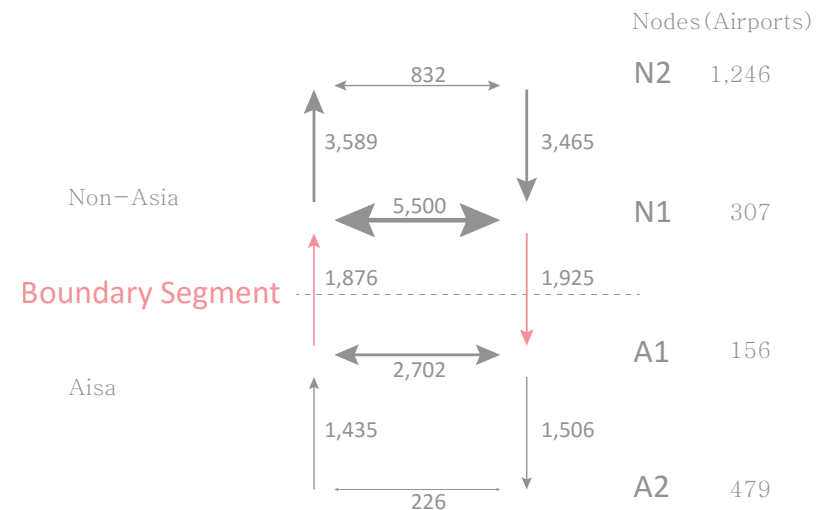# Boundary (segments) network

The nodes in boundary segments might share with each other

the OD information in boundary segments, ...

Case 1 : two nodes of BS share (A rate)

Case 2 : the Asian nodes of BS share the OD in BS

Case 3 : the Non−Asian nodes of BS share the OD in BS

Case 4 : all the nodes of BS share the OD in BS

Nodes (Airports)

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Boundary Segment   1,876   1,925

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2,702

Aisa

1,435   1,506

A2   479

226

The data of the flow between the nodes of BS is as much important as the flow of the BS.
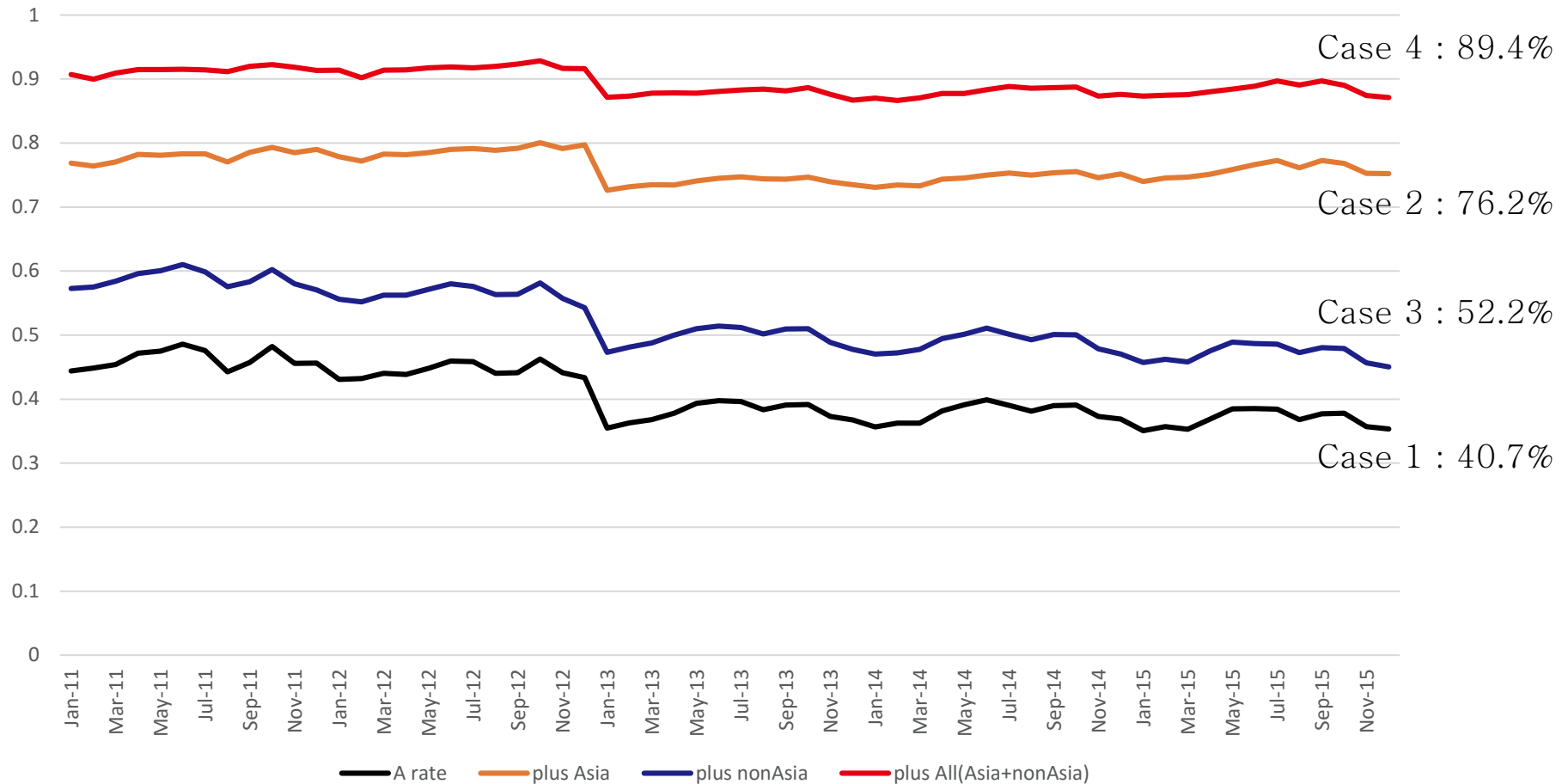
The asymmetry, still, persists. (Case 2 and 3)

Thank you