

Airlines Network

July 2020

1 Introduction

The air transport on time performance historical data used in this study is collected from <https://transtats.bts.gov>. Here, the study is considered for 08(eight) airlines for the period of 1989-2019.

Table 1: Network descriptions

Airlines	# of nodes	# of edges
Southwest	86 (Arpil 03, 2019)	4018
Delta	142 (Arpil 03, 2019)	2809
American	98 (Arpil 03, 2019)	2571
United	96 (Arpil 03, 2019)	1773
Alaska	71 (Arpil 03, 2019)	707
US	67 (Arpil 03, 2015)	1120
Continental	48 (Arpil 03, 2011)	661
Northwest	80 (Arpil 03, 2009)	849

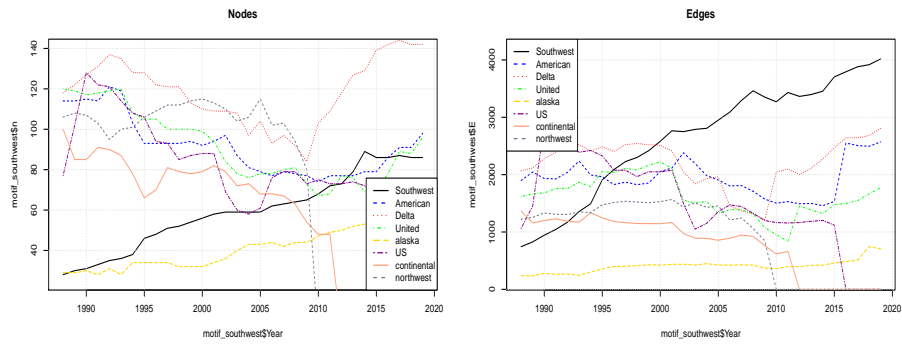


Figure 1: (a) Node, (b) Edge

2 Figure 1

In figure 1a, it seems no. of nodes reduces for all airlines until 2009 except Southwest airlines, then it increases slowly for rest of the period except Delta and Southwest airlines. A large no. of nodes added with Delta airlines between 2009 and 2015. Southwest airlines increases its nodes gradually from the beginning.

In figure 1b, it seems no. of edges remain almost same for all airlines throughout the period except southwest airlines. Southwest airlines increases its edges constantly. There are a continuous positive trend for Delta airlines after 2009. No. of Edges for American airways had a sharp increase in 2016.

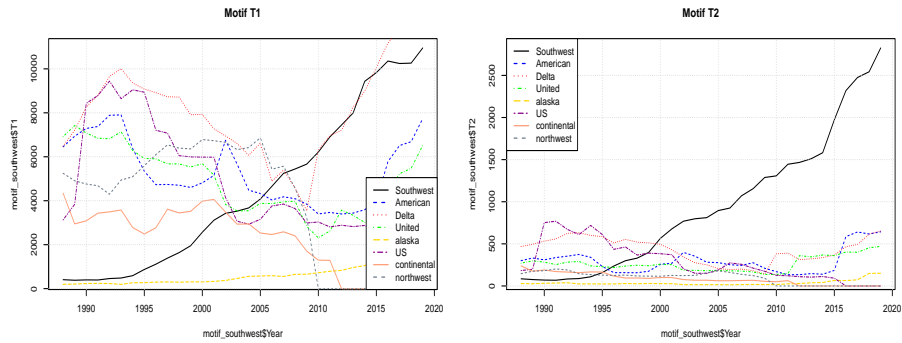


Figure 2: (a) Motif T1, (b) Motif T2

3 Figure 2

Figure 2a gives the impression that motif T1 reduces for all airlines until 2009 except Southwest airlines, then it increases slowly for rest of the period except Delta and southwest airlines. Motif t1 rises drastically for Delta airlines after 2009. Southwest airlines' motif T1 rises continuously throughout the period.

Figure 2b clearly shows that motif T2 remain almost same throughout the period for all airlines except southwest airlines. Southwest airlines' motif T2 rises continuously throughout the period. Motif T2 for American airways had a sharp increase in 2016.

4 Figure 3

In Figure 3a, it seems motif V1 has both slight upward and downward trend for all airlines but it remain almost same throughout the period except Delta airlines. Southwest airlines' motif V1 has a continuous positive trend. There are a sharp increase of motif V1 for Delta airlines between 2009 and 2016.

In Figure 3b, it seems motif V2 has continuous decreasing trend for all airlines until 2009 except southwest airlines and US airways. US airways has

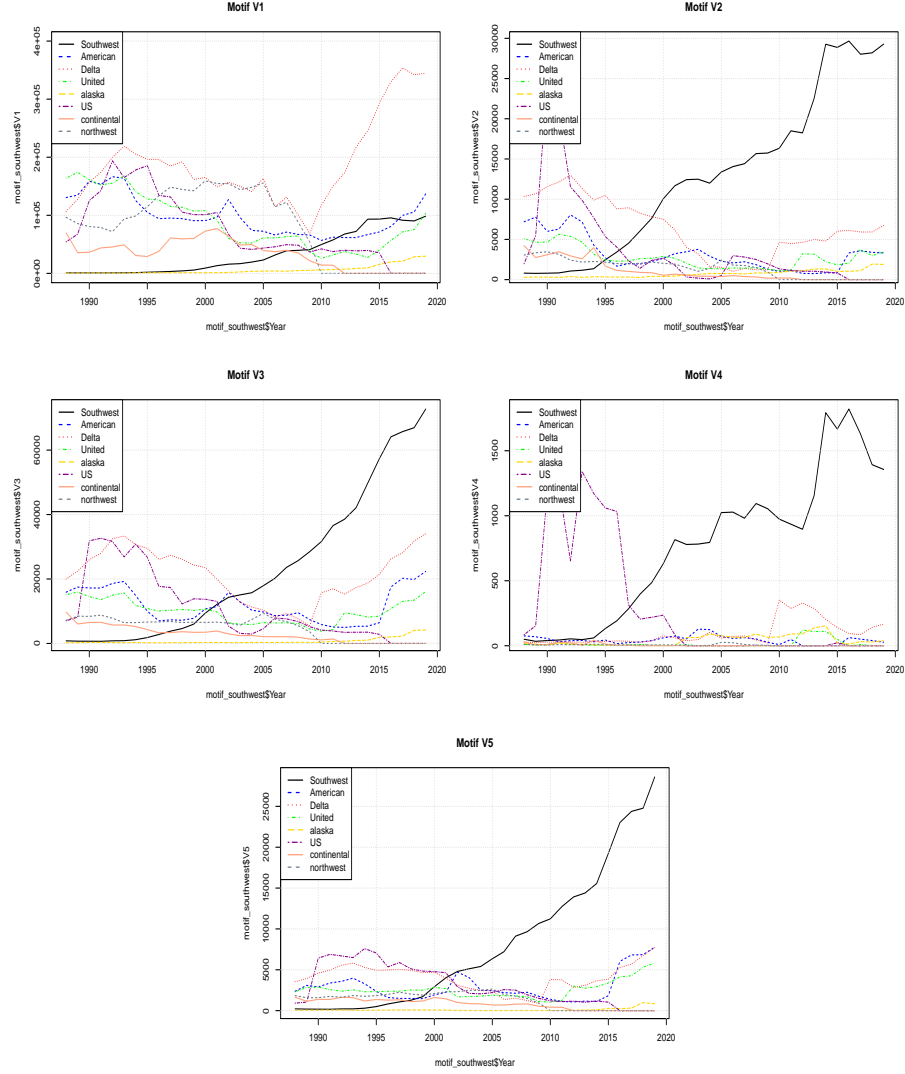


Figure 3: (a) Motif V1, (b) Motif V2, (c) Motif V3, (d) Motif V4, and (e) Motif V5

a spike on the graph in 1991, later it falls drastically between 1993 and 1996. Southwest airlines' motif V2 increases with a positive trend after 1994. Delta and American airlines' motif V2 increases after 2006 and 2015 respectively.

In Figure 3c, it seems motif V3 has continuous decreasing trend for all airlines until 2009 except southwest airlines and US airways. US airways has a jump on the graph in 1991, later it falls drastically between 1993 and 1996. Southwest

airlines' motif V3 increases with a positive trend after 1996. Delta and American airlines' motif V3 increases after 2006 and 2015 respectively.

In Figure 3d, it clears that motif V4 remain almost same for all airlines throughout the period except southwest airlines, Delta airlines and US airways. US airways has few jumps between 1991 and 2002 before it's getting flat. Southwest airlines' motif V4 increases with a positive trend after 1994 while it has a sharp increase in 2013. Delta airlines' motif V4 increases after 2006.

In Figure 3e, it clears that motif V5 remain almost same for all airlines throughout the period except southwest airlines. Southwest airlines' motif V5 increases with a positive trend after 1996.



Figure 4: (a) Concentration T1, (b) Concentration T2

5 Figure 4

Figure 4a indicates that concentration T1 did not change noticeably else Alaska airline. Alaska airlines has a upward trend for concentration T1 until 2002, then it remains almost same for the rest of the period.

Figure 4b clearly shows that concentration T2 remain almost same throughout the period for all airlines.

6 Figure 5

In Figure 5a, it seems concentration V1 remain almost same throughout the study period for all airlines except Southwest and Alaska airlines, while these two have a positive trend.

In Figure 5a, it seems concentration V1 remain almost same throughout the study period for all airlines except Southwest and Alaska airlines, while both of them have a negative trend.

In Figure 5c, it seems concentration V3 did not change noticeably for all airlines except Alaska airlines, it has a negative trend at the first decade before it's getting flat.

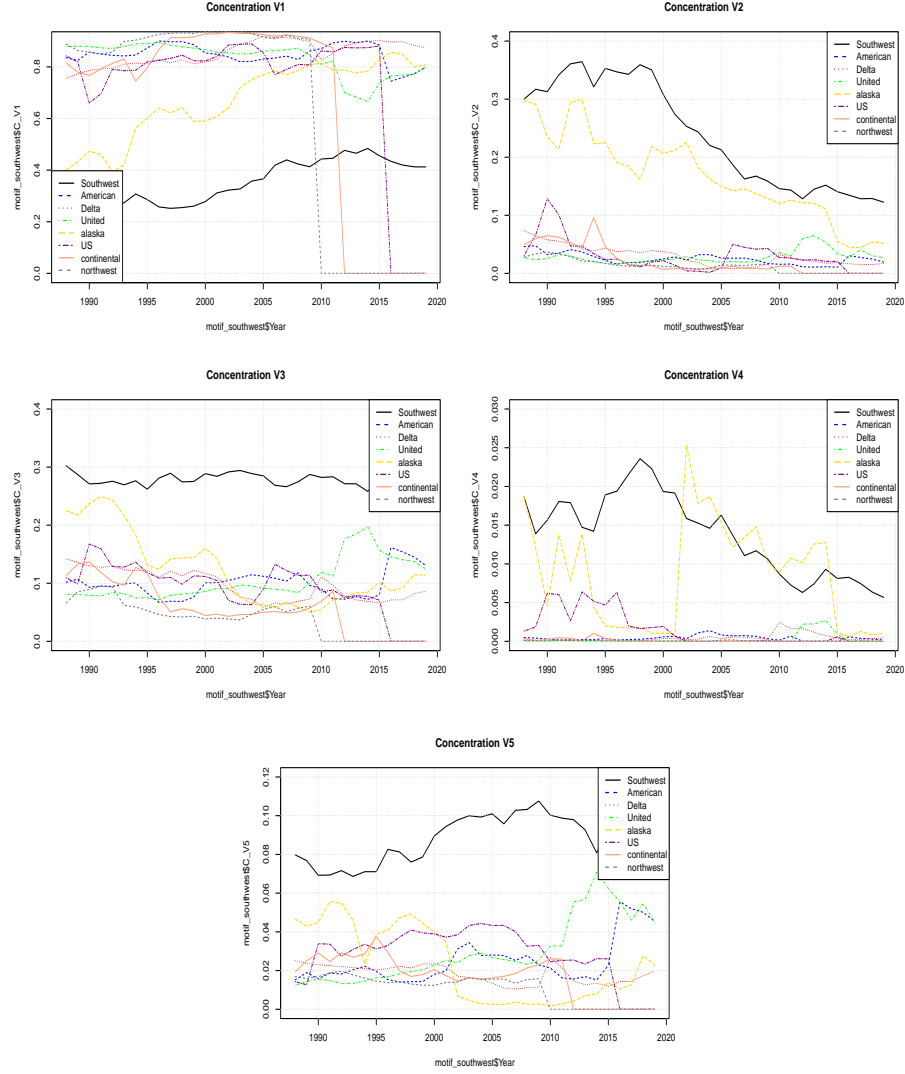


Figure 5: (a) Concentration V1, (b) Concentration V2, (c) Concentration V3, (d) Concentration V4, and (e) Concentration V5

In Figure 5d, it clears that most airlines concentration V4 remain almost same throughout the period except Southwest airlines, Alaska airlines and US airways. US airways has few jumps between 1989 and 1997 before it's getting flat. Southwest airlines' concentration V4 reduces over time, though it increased between 1995 and 1997. Alaska airlines' concentration V4 line has several spikes in it's graph.

In Figure 5e, it clears that concentration V5 remain almost same for all airlines throughout the period.

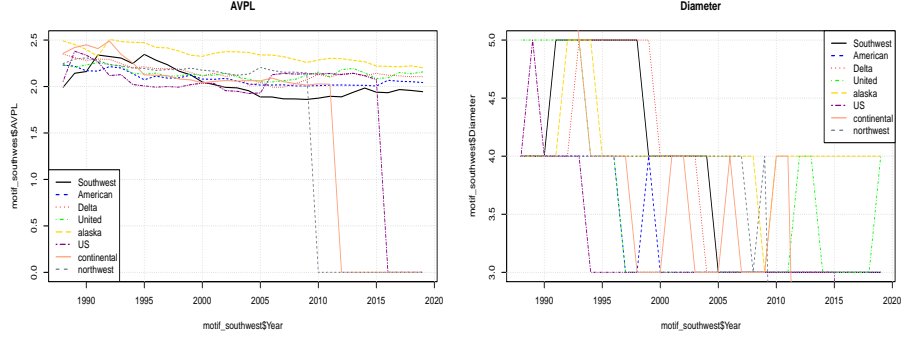


Figure 6: (a) AVPL, (b) Diameter

7 Figure 6

Figure 6a gives the impression that AVPL did not change noticeably over the period.

8 Figure 7

Figure 7 gives the impression that there are a relation between no. of nodes and no. of edges, when the no. of nodes increases no. of edges also increases except for the American airlines data.

9 Figure 8

Figure 8 shows clearly that no. of motif T1 increases while no. of nodes increases.

10 Figure 9

In Figure 9, it seems that there are a relation between no. of nodes and motif T2 for most airlines besides the data scatter for American and United airlines. It appears that there are few outliers for Southwest, Alaska airlines.

11 Figure 10

From Figure 10, it's obvious to say no. of motif V1 increases with no. of nodes.

12 Figure 11

From Figure 11, it's safe to say no. of motif V2 increases with no. of nodes.

13 Figure 12

In Figure 12, it seems that there are a relation between motif V2 and no. of nodes.

14 Figure 13

In Figure 13, it's hard to find a common relation between no. of nodes and no. of motif V4. It seems southwest airlines motif V4 increases with no. of nodes.

15 Figure 14

In Figure 14, it seems no. of motif V5 increases when no. of nodes increase for Southwest, Delta, Continental, Northwest airlines and US airways.

16 Figure 15

In Figure 15, it's hard to find any relation between node and concentration T1. Some airlines has almost same concentration T1 for the whole study period, whereas some airlines has scatter concentration data with no. of nodes.

17 Figure 16

In Figure 16, it's hard to see any common pattern between node and concentration T2. In some airlines, it seems no. of concentration T2 decreases while no. of nodes increases.

18 Figure 17

In Figure 17, it's hard to find any common relation between node and concentration V1. No. of concentration V1 increases while no. of nodes increases for Southwest and Alaska airlines.

19 Figure 18

In Figure 18, it's hard to find any common pattern between node and concentration V2. In some cases, no. of concentration V2 increases while no. of nodes

increases, whereas in some cases no. of concentration V2 decreases with no. of nodes.

20 Figure 19

In Figure 19, it's hard to find any common pattern between node and concentration V3. In some cases, no. of concentration V3 increases while no. of nodes increases, whereas in some cases no. of concentration V3 decreases with no. of nodes and in some airlines it didn't show any pattern.

21 Figure 20

In Figure 20, it's hard to find any common pattern between node and concentration V4.

22 Figure 21

In Figure 21, it's hard to find any common pattern between node and concentration V5.

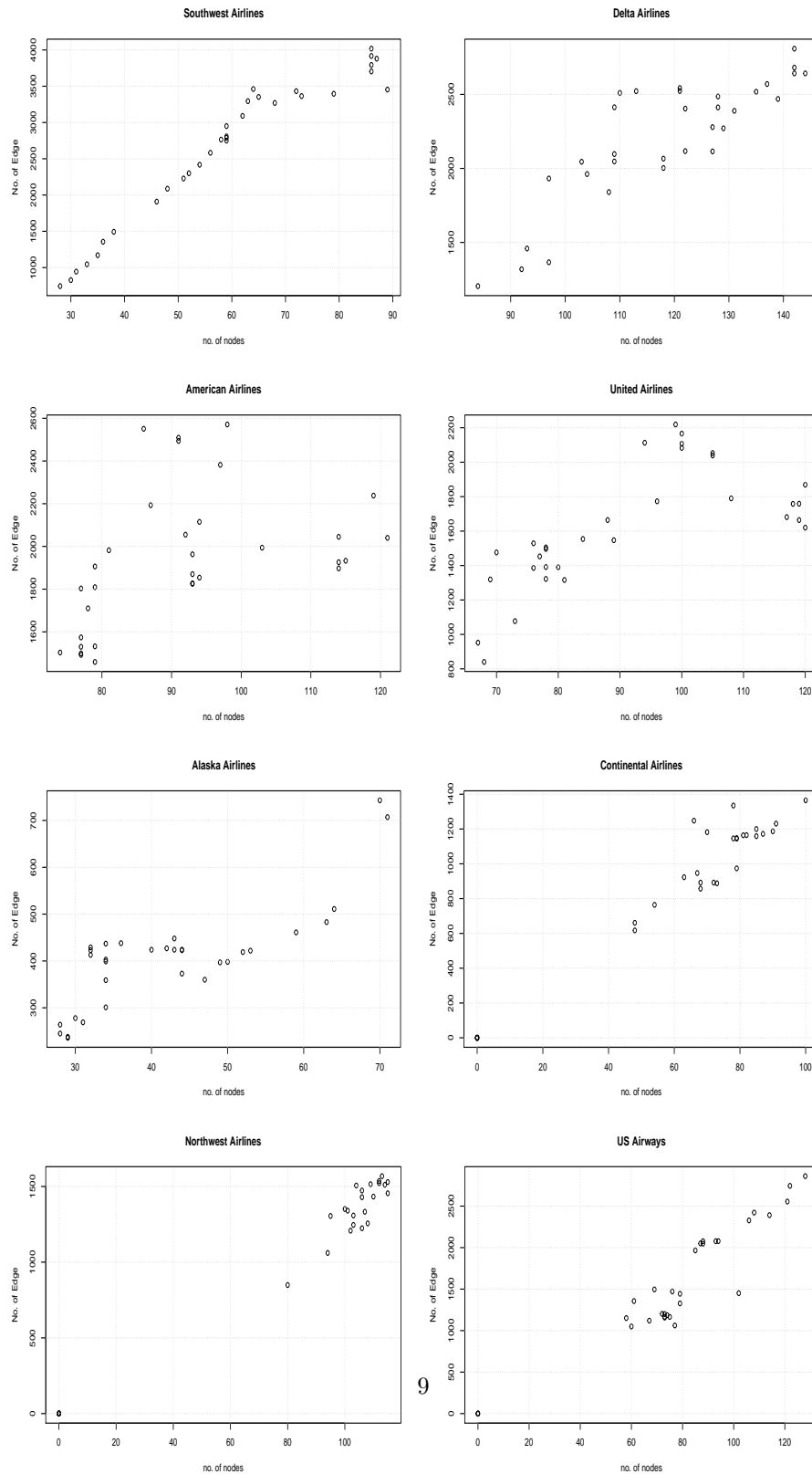


Figure 7: Node vs Edge

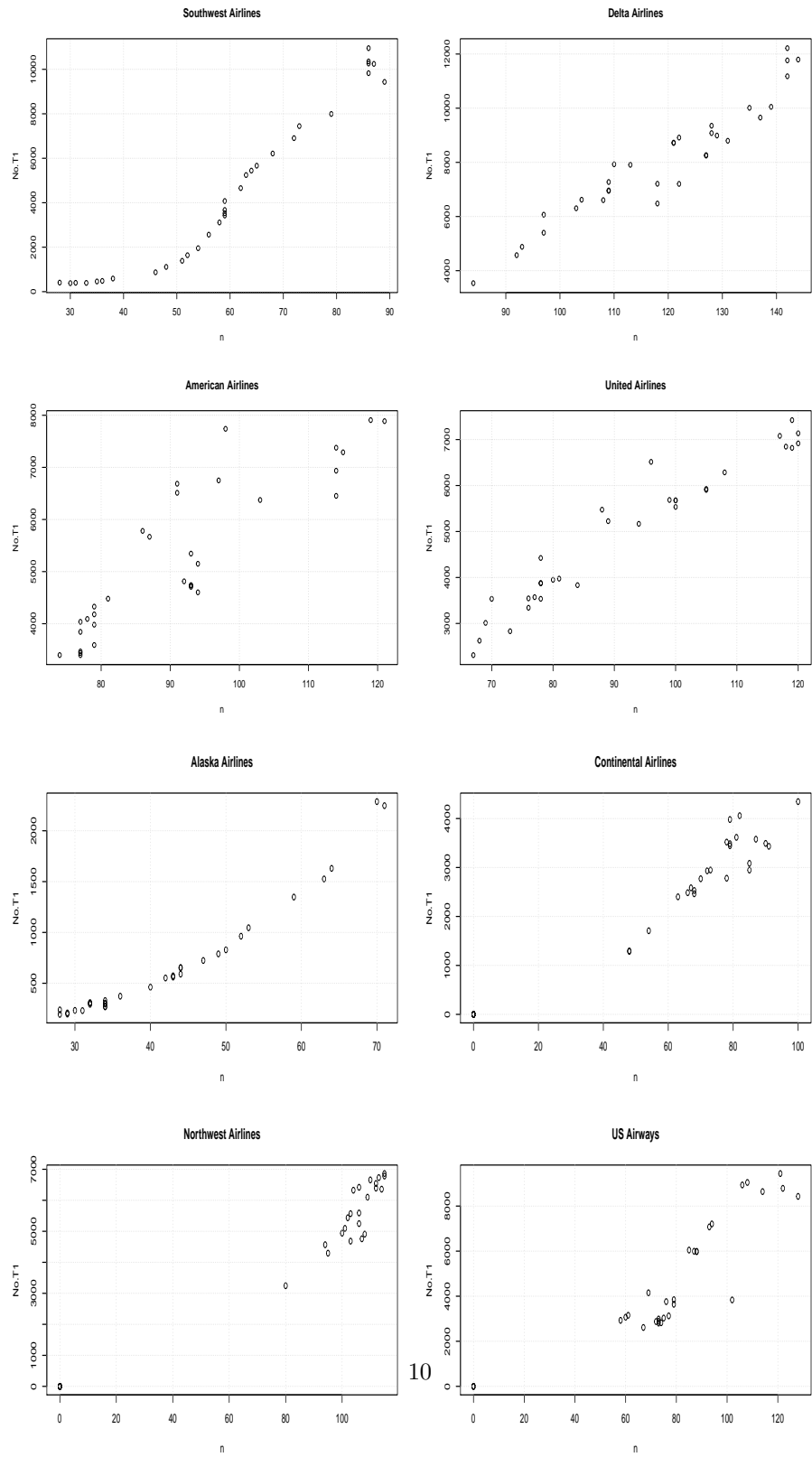


Figure 8: Node vs Motif T1

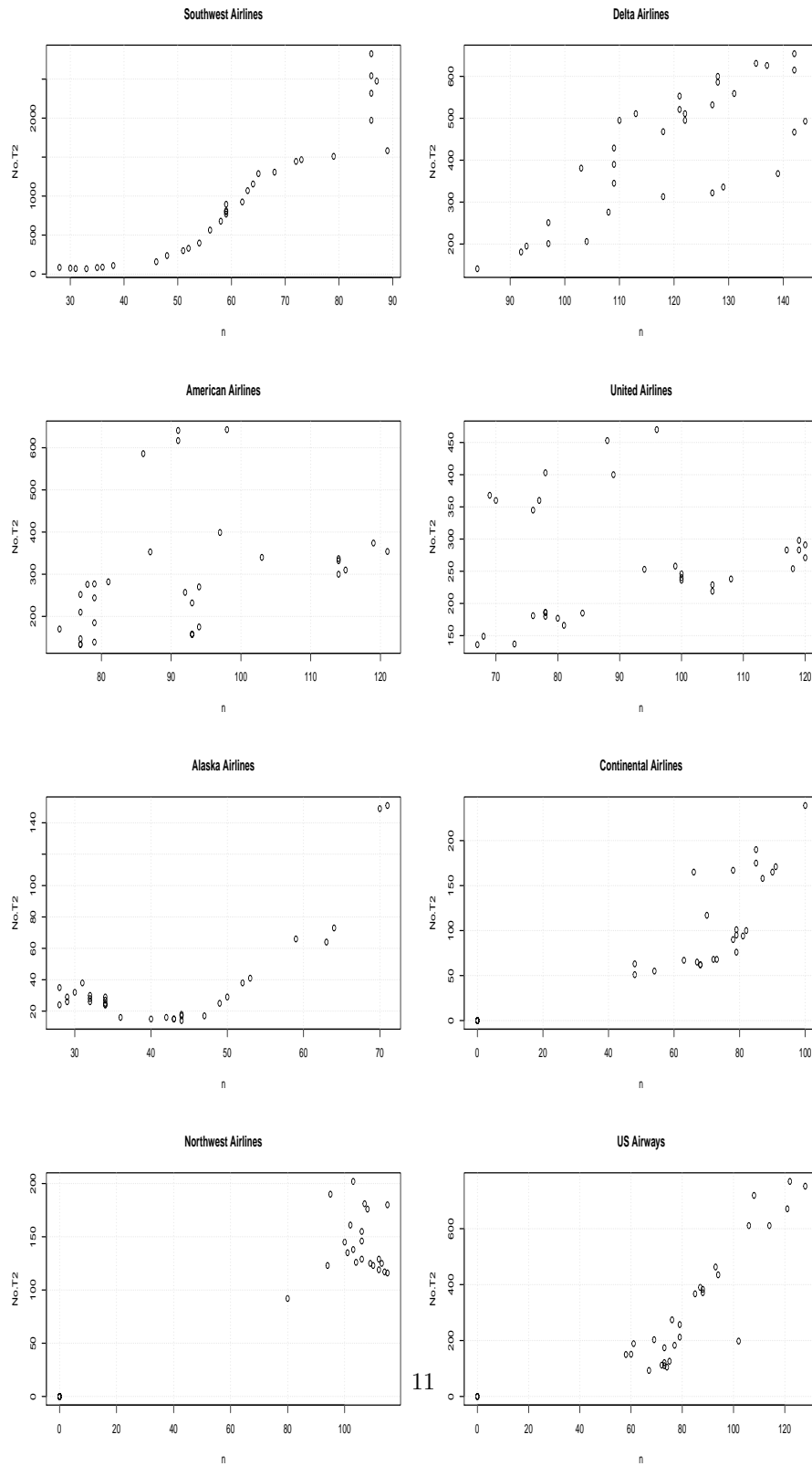


Figure 9: Node vs Motif T2

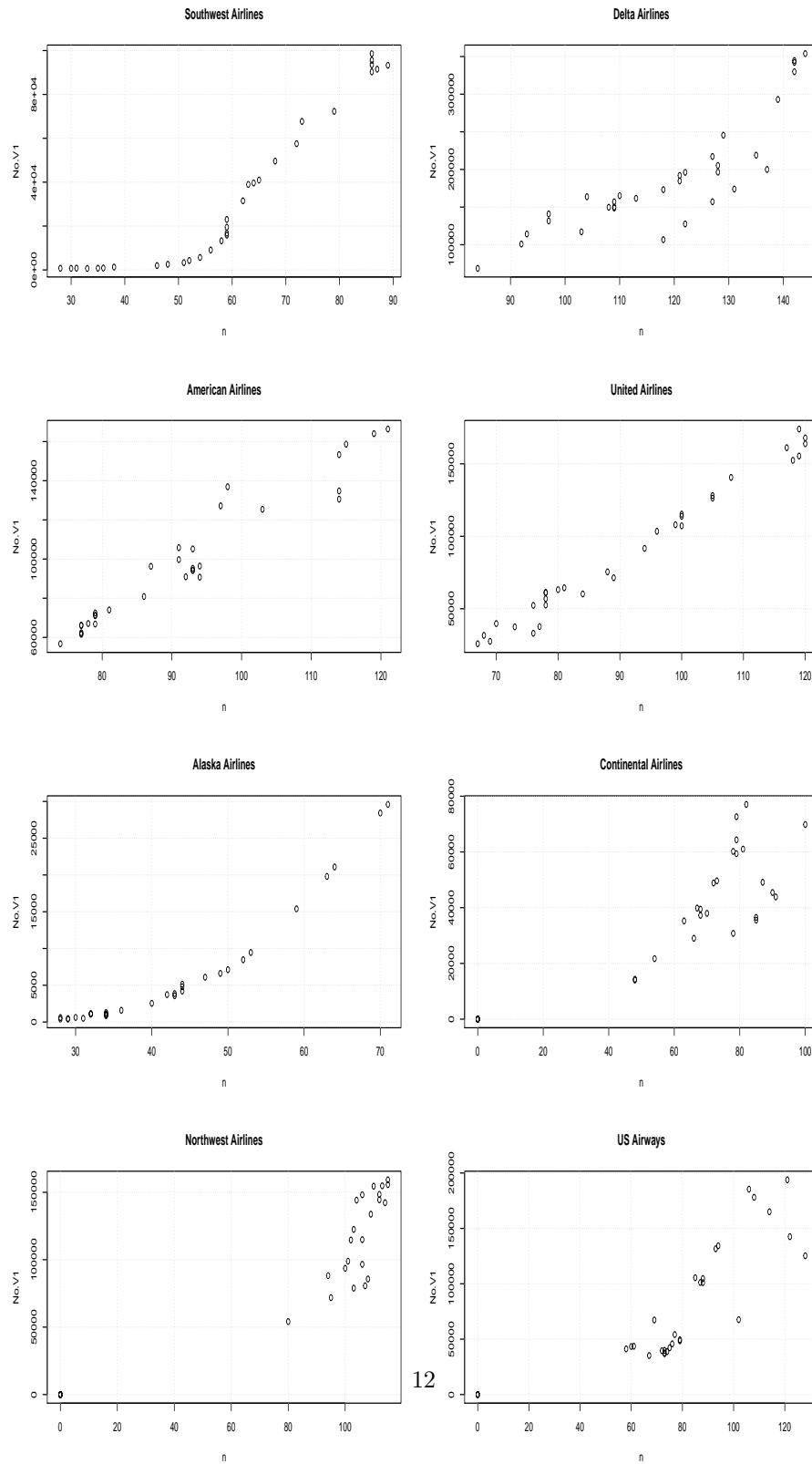


Figure 10: Node vs Motif V1

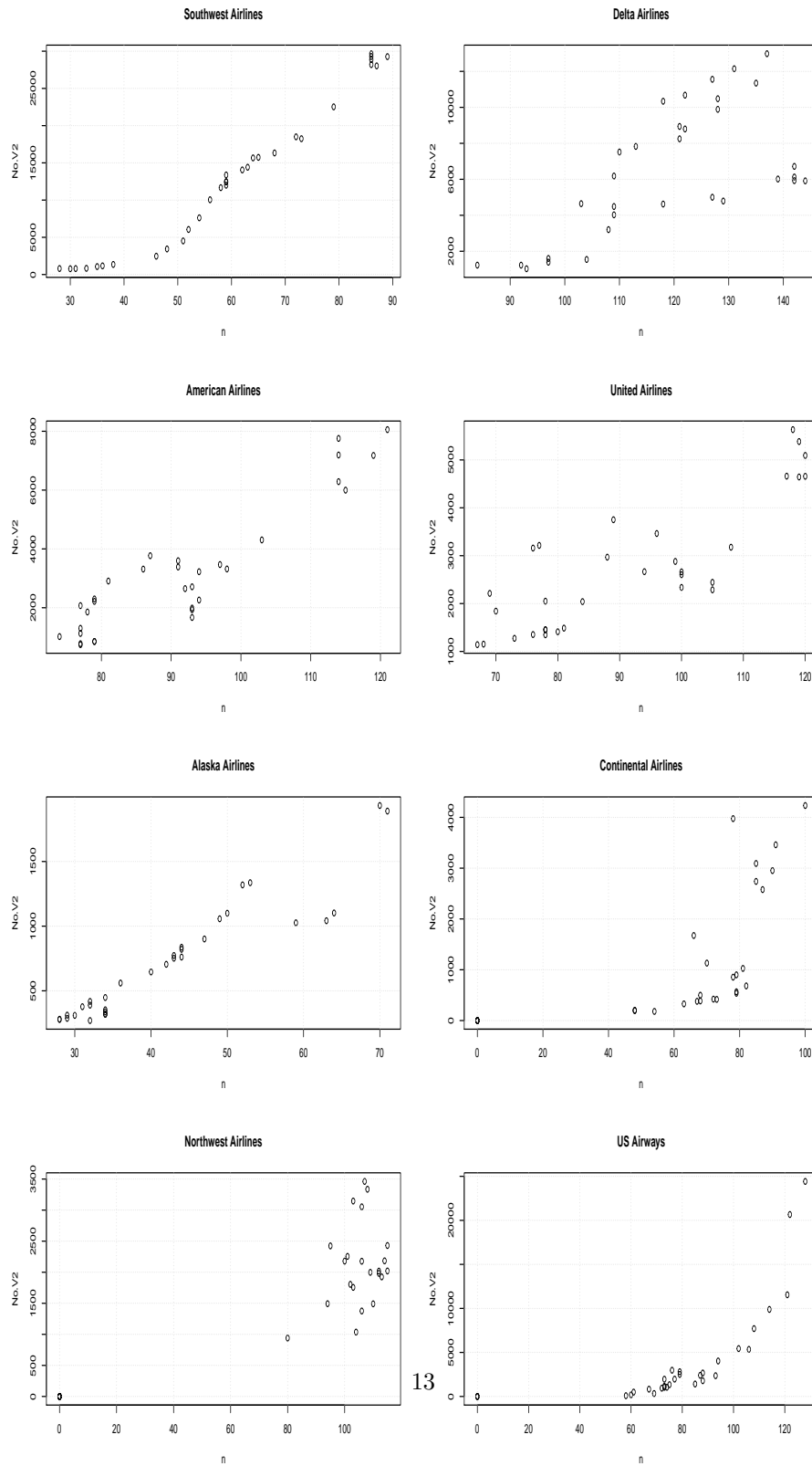


Figure 11: Node vs Motif V2

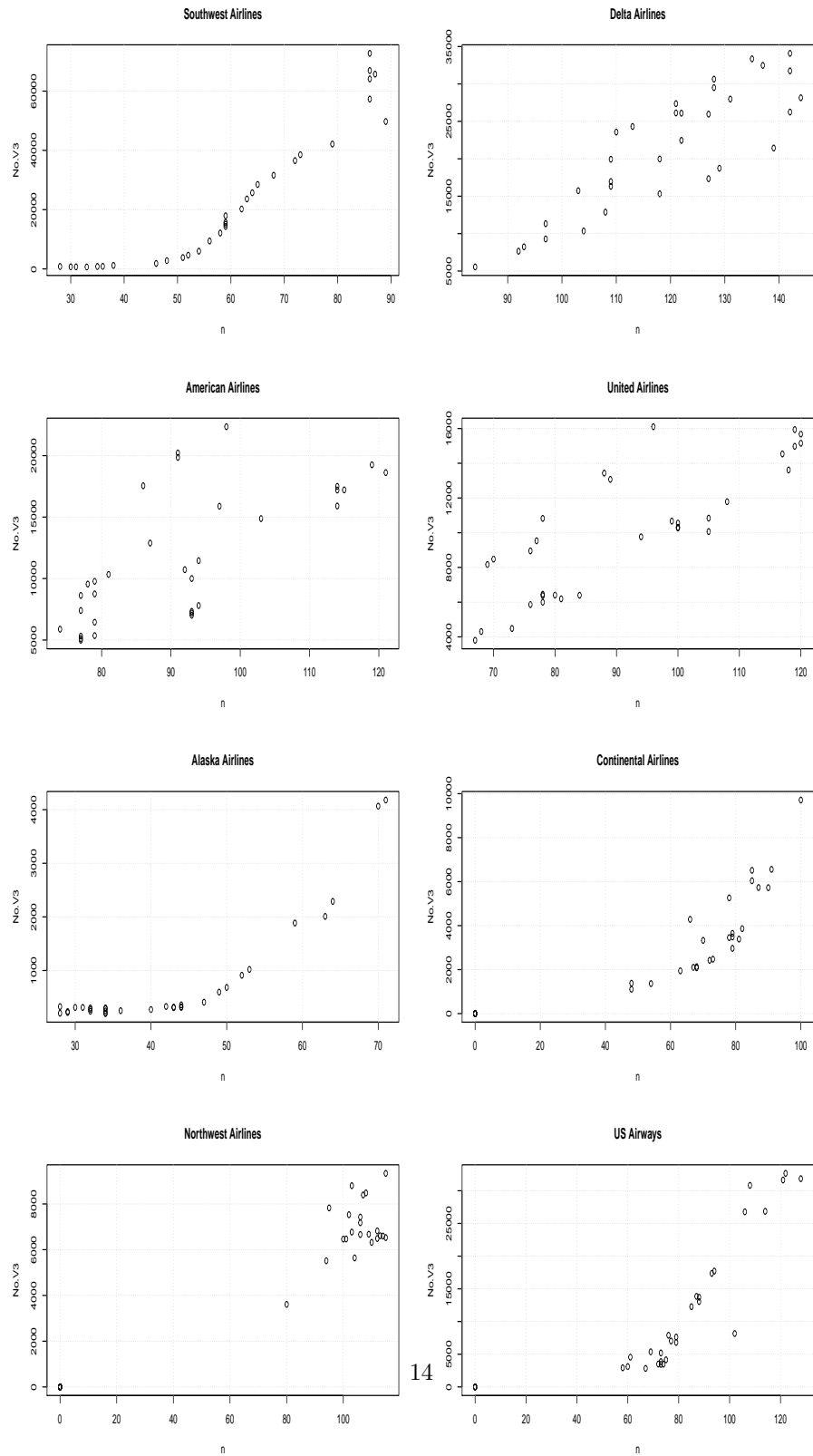


Figure 12: Node vs Motif V3

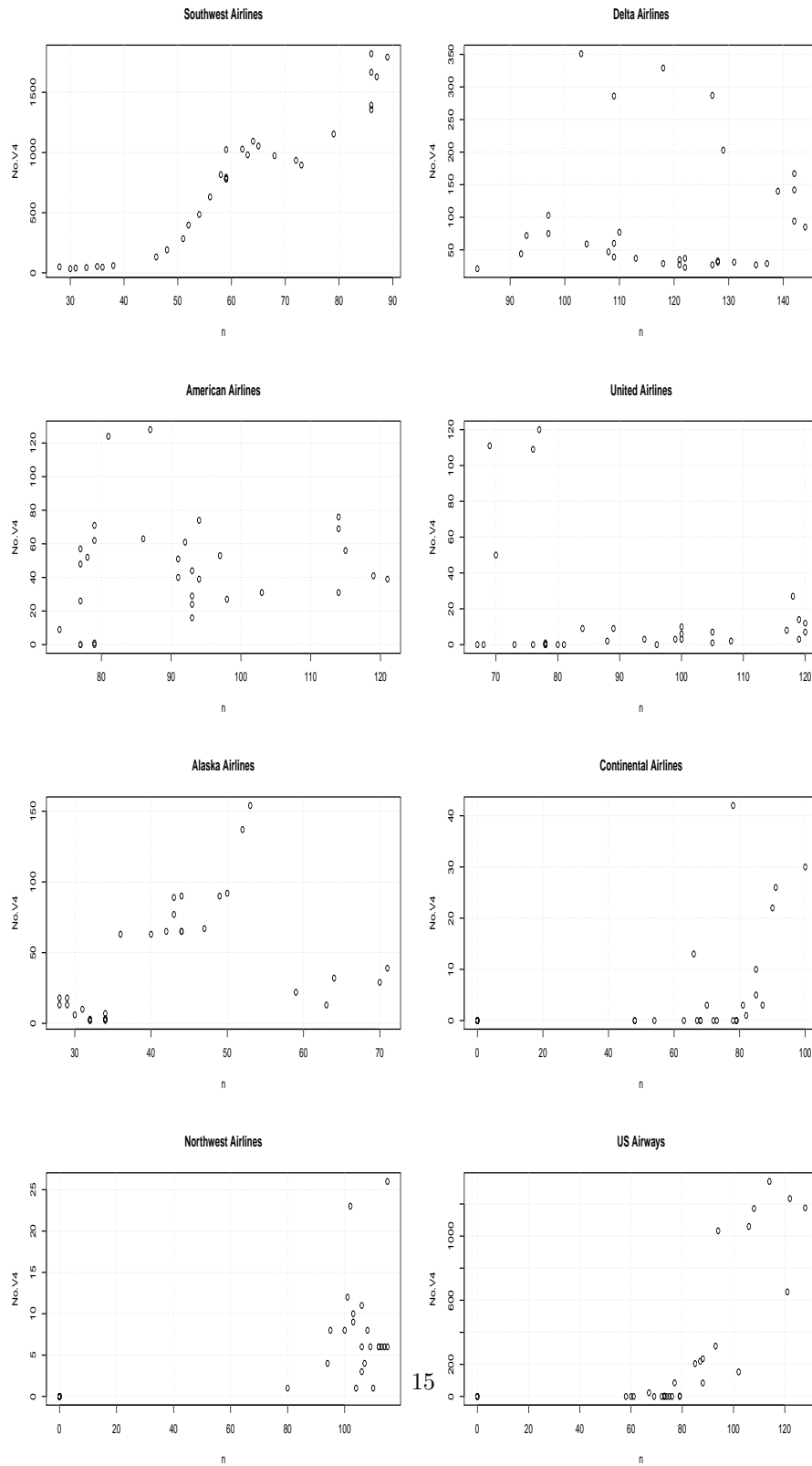


Figure 13: Node vs Motif V4

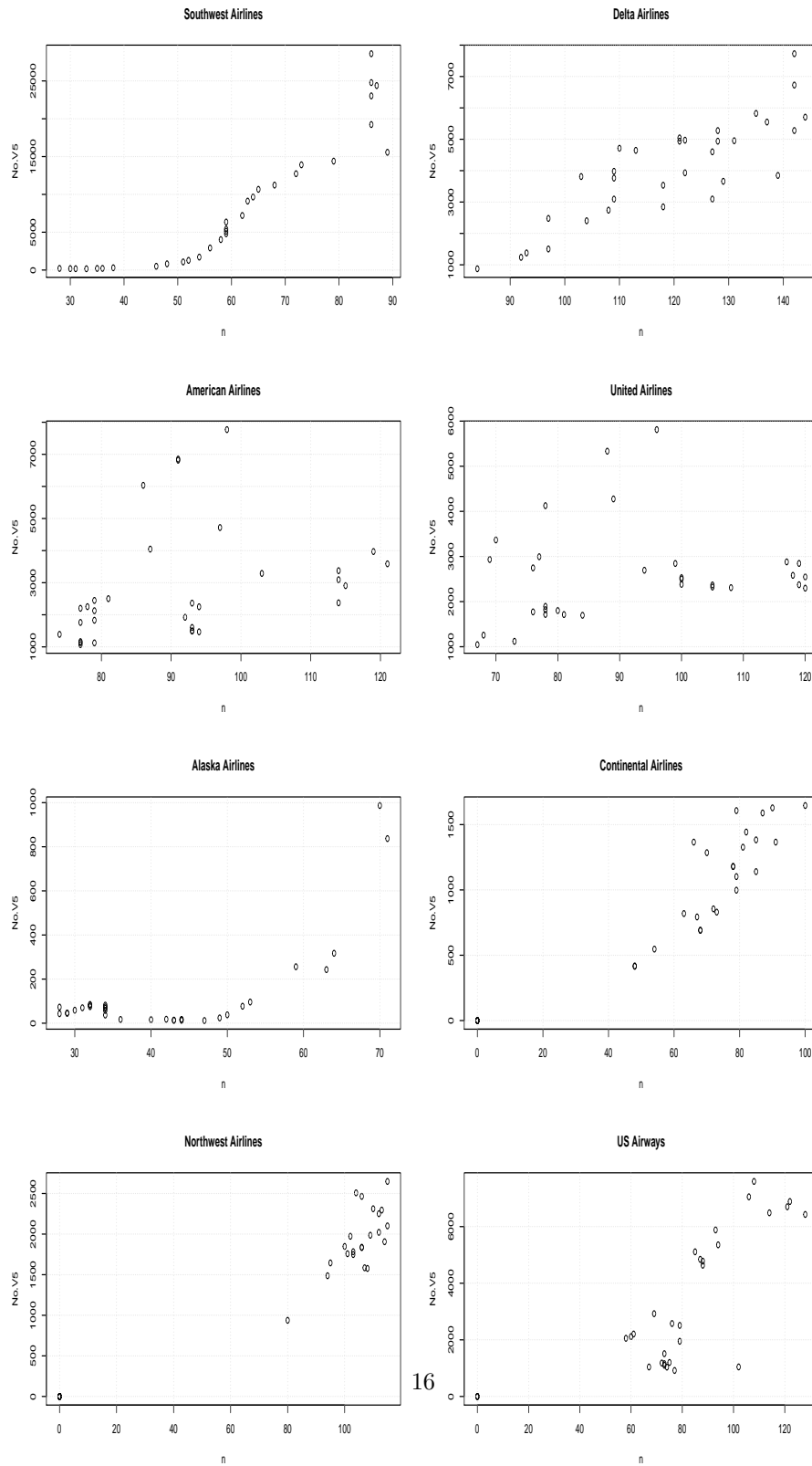


Figure 14: Node vs Motif V5

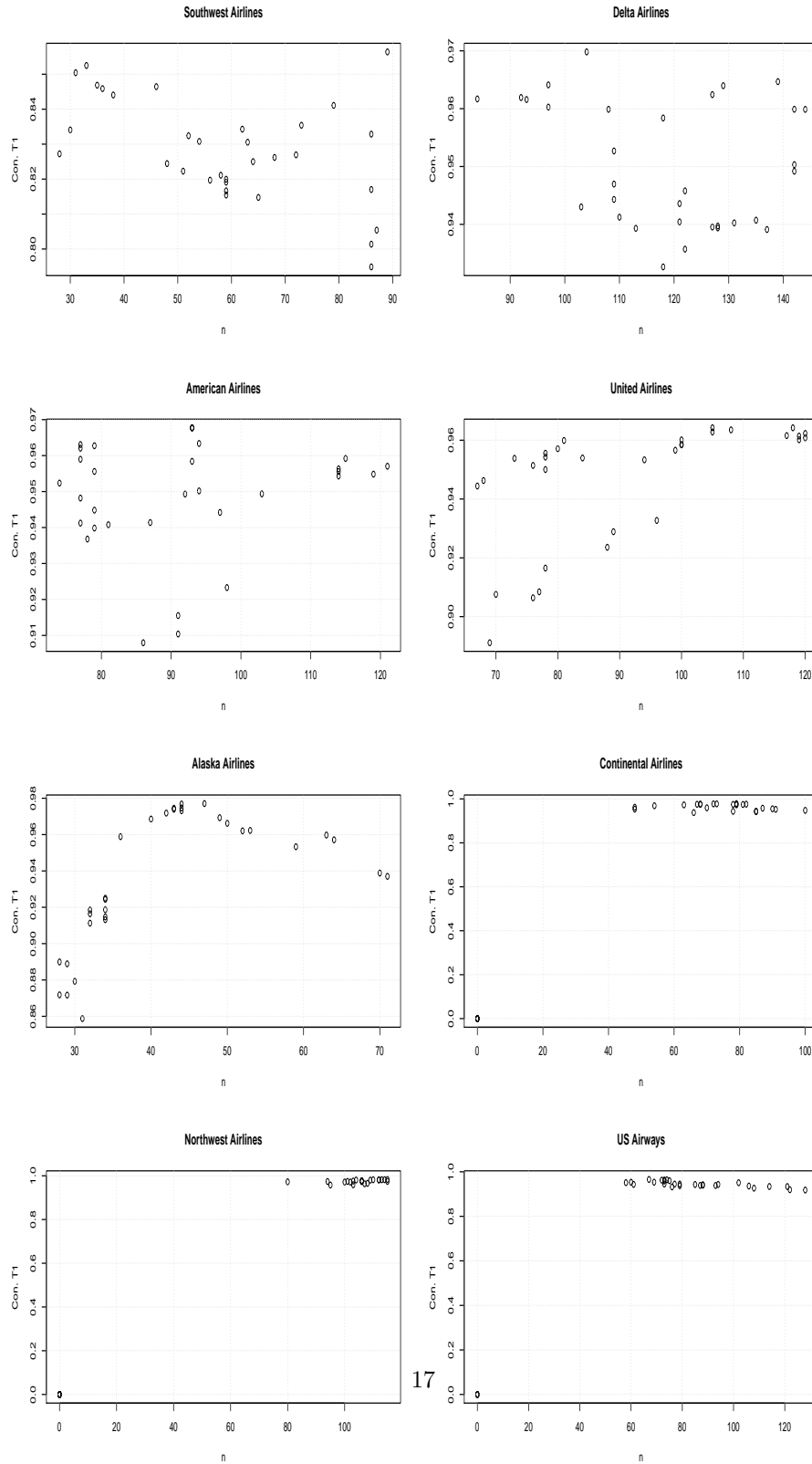


Figure 15: Node vs Concentration T1

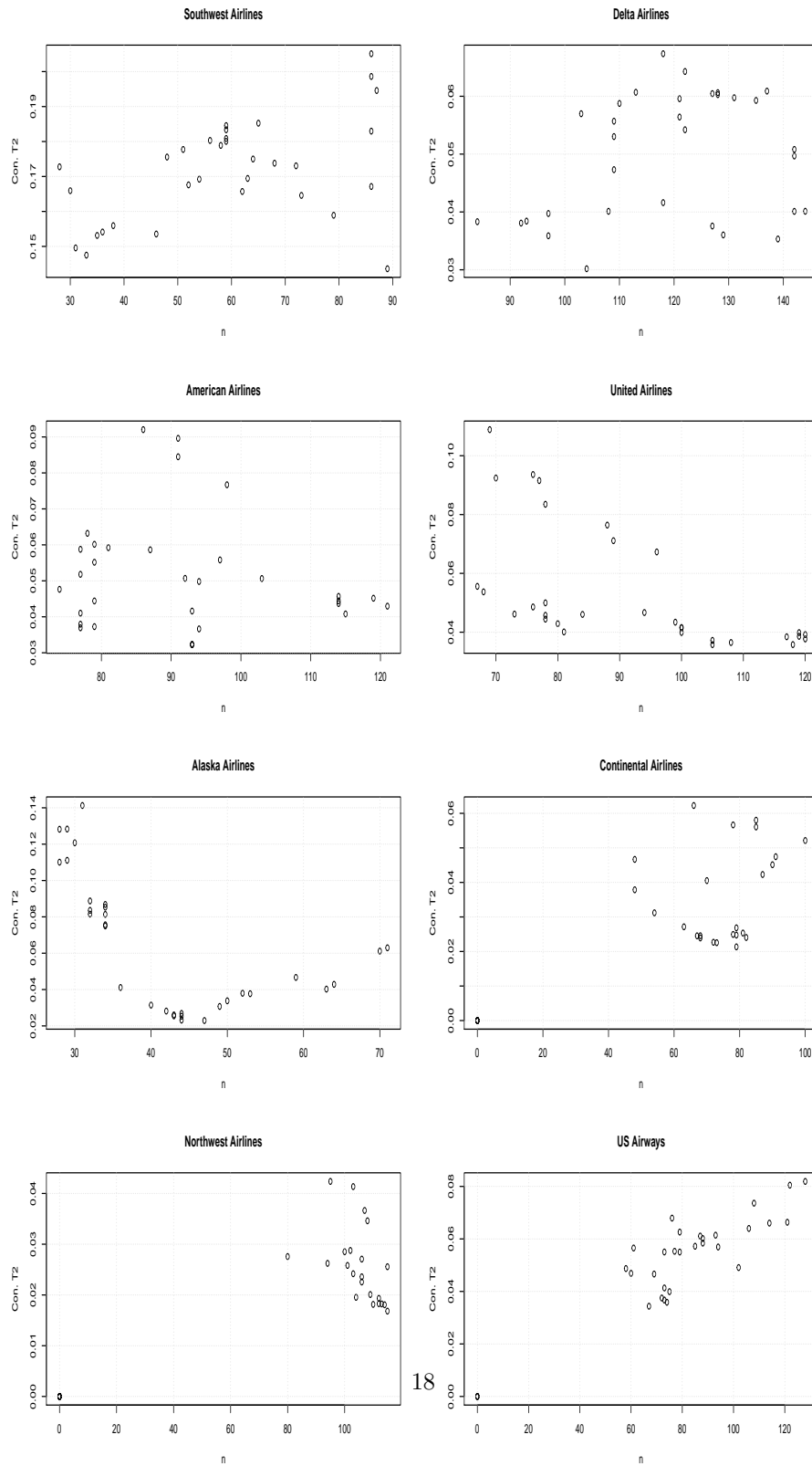


Figure 16: Node vs Concentration T2

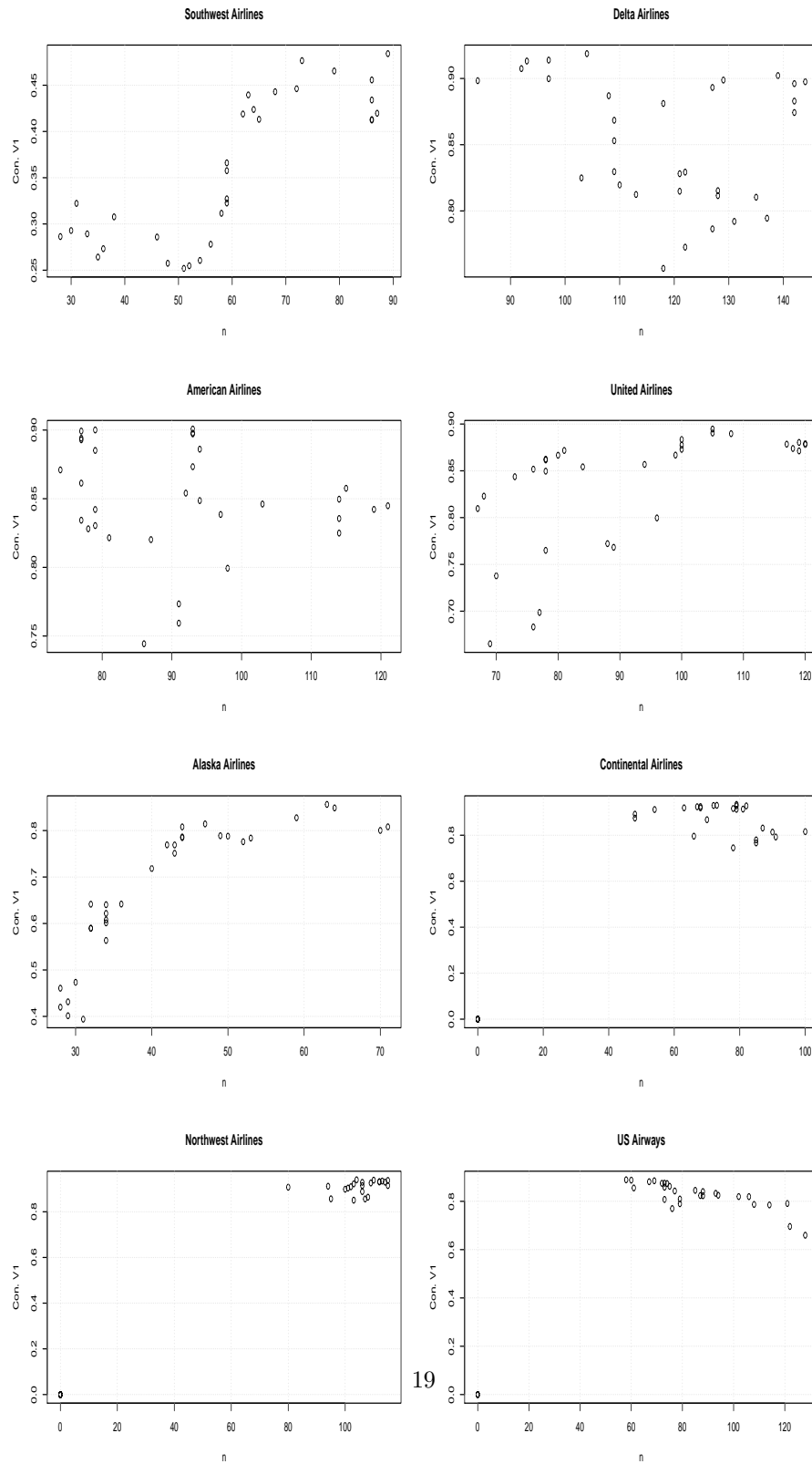


Figure 17: Node vs Concentration V1

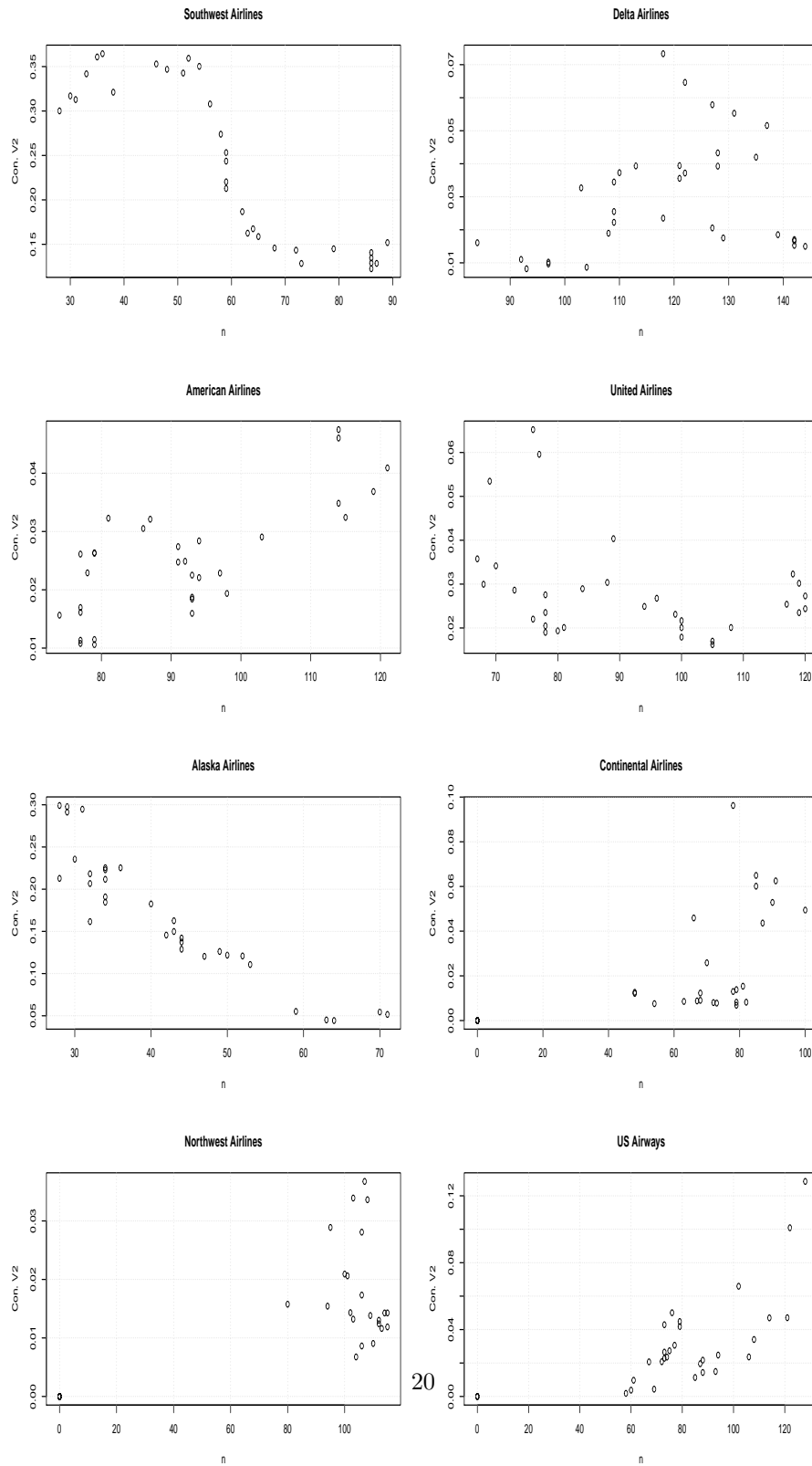


Figure 18: Node vs Concentration V2

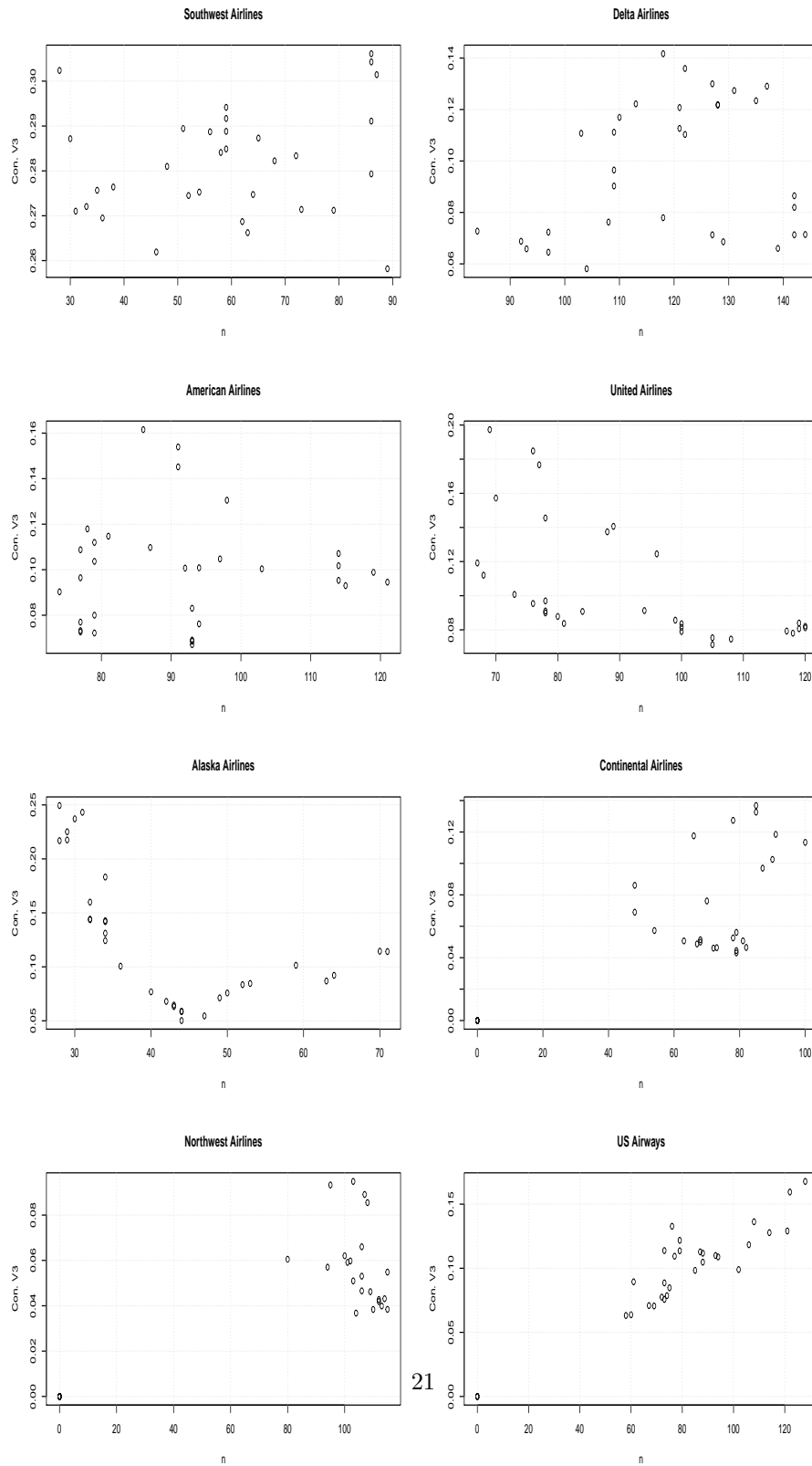


Figure 19: Node vs Concentration V_3

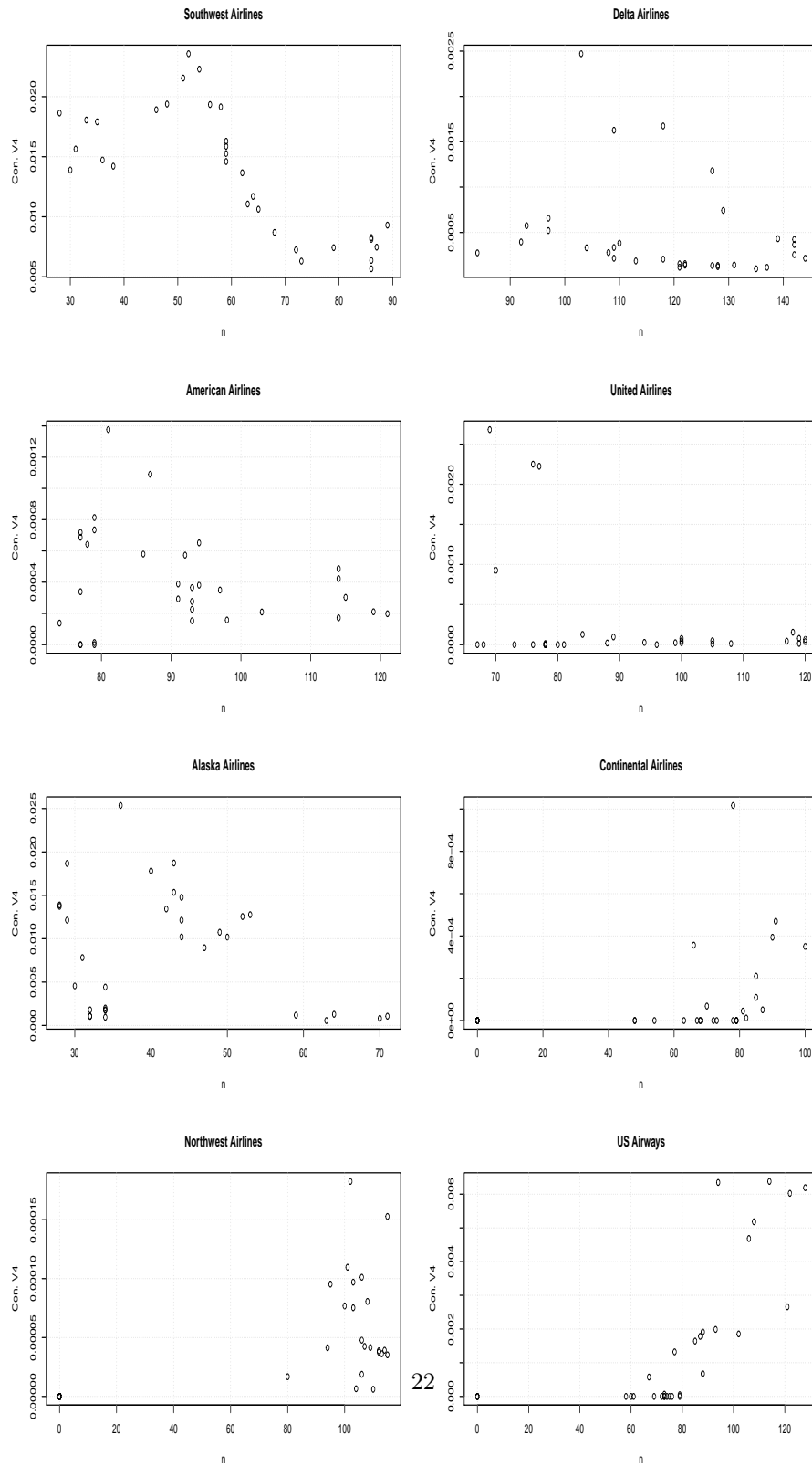


Figure 20: Node vs Concentration V4

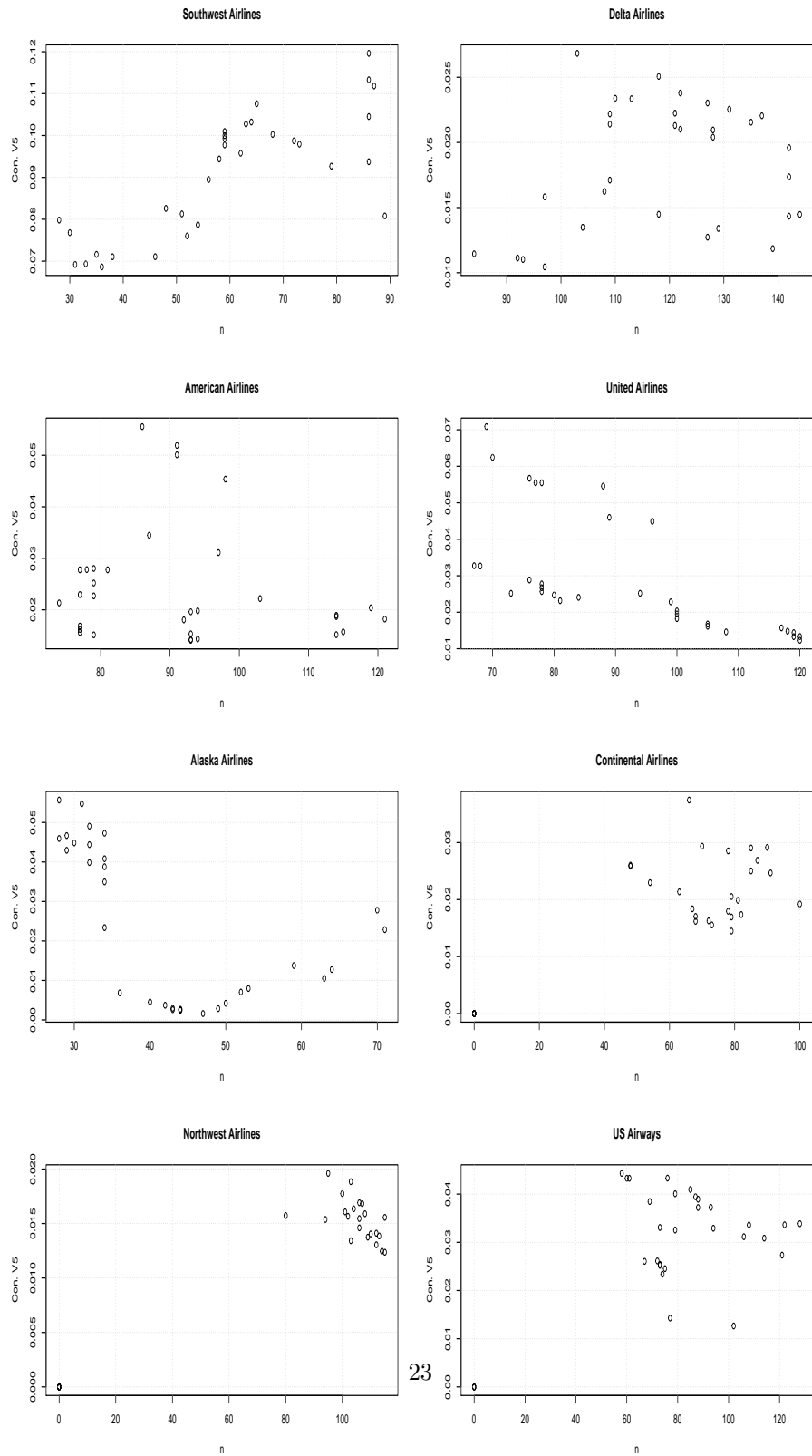


Figure 21: Node vs Concentration V5