July 2002

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Working Paper 2002-23

July 2002

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Abstract

This paper considers the aggregate performance of the banking industry, applying a modified and extended dynamic decomposition of bank return on equity. The aggregate performance of any industry depends on the underlying microeconomic dynamics within that industry – adjustments within banks, reallocations between banks, entry of new banks, and exit of existing banks. Bailey, Hulten, and Campbell (1992) and Haltiwanger (1997) develop dynamic decompositions of industry performance. We extend those analyses to derive an ideal dynamic decomposition that includes their dynamic decomposition as one component. We also extend the decomposition, consider geography, and implement decomposition on a state-by-state basis, linking that geographic decomposition back to the national level. We then consider how deregulation of geographic restrictions on bank activity affects the components of the state-level dynamic decomposition, controlling for competition and the state of the economy within each state and employing fixed- and random-effects estimation for a panel database across the fifty states and the District of Columbia from 1976 to 2000.

Journal of Economic Literature Classification: L1, G2

Keywords: aggregate fluctuations, dynamic decomposition, productivity

1. Introduction

The U.S. banking industry provides fertile ground for cultivating research on industry dynamics under regulatory change. The historical development of U.S. institutions, with the strong aversion to concentrations of power and with the significant regulation in the banking sector enacted in response to the Great Depression, generated an industry encompassing many more banks than the norm around the world. During the 1970s, financial innovations frequently circumvented existing regulation. Those innovations gradually eroded the effect of existing regulations, ultimately dismantling much of the regulatory superstructure erected during the Great Depression. Thus, the last two decades of the 20th century witnessed a chain of deregulatory actions that unlocked the regulatory handcuffs, enacted during the Great Depression. For example, the prohibition against intrastate and interstate banking slowly devolved, first with a series of relaxations of regulation on a state-by-state basis, then by growing state-level actions permitting interstate banking activity through multibank holding companies, and finally with the adoption of full interstate banking with the passage of the Interstate Banking and Branching Efficiency Act of 1994. In sum, the deregulation of geographic restrictions on banking activity at the state and national levels provides a most unusual real-world experiment on the effects of such deregulation on banking behavior and performance.[1]

We examine the performance of the banking industry, measured by the rate of return on equity, at the national and state-by-state levels. Aggregate bank performance decomposes into effects due to adjustments within banks, reallocations between banks, entry of new banks, and exit of existing banks. We modify and extend the existing literature on decomposing industry

[1] Existing work considers the effects of deregulation on various banking issues. For example, how did deregulation affect bank new charters, failures, and mergers (Amos, 1992; Cebula, 1994: Jeon and Miller, 2002a) and bank

performance measures (Bailey, Hulten, and Campbell, 1992; Haltiwanger 1997). We also explore the effects of the deregulation of geographic restrictions on banking on the state-by-state within, between, entry, and exit components of the dynamic decomposition of bank performance (return on equity). In addition, we control for the level of competition and the state of the economy in each state, employing fixed- and random-effect regressions in the panel database across the fifty states and the District of Columbia from 1976 to 2000,

The dynamic decomposition of industry performance requires micro-level information on firms (banks) within an industry. The availability of micro-level (establishment-level) data for manufacturing industries spawned a series of such applied microeconomic research.[2] That research effort reveals more heterogeneity among firms and/or plants within the same industry than between industries. In sum, aggregate industry data hide important firm- and/or plant-level dynamics that collectively determine overall industry dynamics.

Bailey, Hulten, and Campbell (1992) provide an algebraic decomposition of industry total factor productivity (TFP) growth into three effects – "within," "between," and "net-entry" effects. The within effect measures the contribution of surviving firms toward TFP growth. The between (or reallocation) effect measures the contribution of changing market share of surviving firms toward TFP growth, while the net-entry effect measures the contribution of firms entrants into and exits from the industry toward TFP growth. Haltiwanger (1997) extends Bailey, Hulten, and Campbell (1992) and separates the effects of firm entrants into and exit from the industry. Moreover, he also divides the between effect into two components – the "share" and "covariance" effects. The share effect measures the contribution toward aggregate TFP growth of

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performance (Jayaratne and Strahan, 1997, 1998; Jeon and Miller, 2002b).

[2] McGuckin (1995) describes the Longitudinal Research Database (LRD) at the U.S. Bureau of the Census upon

the changing share of firms while the covariance effect measures the contribution toward aggregate TFP growth of the changing share of firms times the changing TFP growth of firms.[3] Stiroh (1999), using U.S. banking data, further decomposes Haltiwanger's (1997) method by dividing banks into those that acquired other banks and those that did not.

Such decomposition methods share a common index-number problem – the choice of the base year. Bailey, Hulten, and Campbell (1992), Haltiwanger (1997), and Stiroh (1999) choose the initial year as the base for their calculations. Thus, the within effect measures the change in TFP growth at the firm level between the initial and final years weighted by the initial year's market share. [In the price index literature, that choice is analogous to the Laspeyres price index due to Laspeyres (1871).] One can complete a decomposition of within, between (reallocation), entry, and exit effects when the final year provides the base as well. That is, the within effect weights the change in TFP growth between the initial and final years for each firm by the firm's industry share in the final year. [In the price index literature, that choice is analogous to the Paasche price index due to Paasche (1874).] Finally, an ideal dynamic decomposition combines these two dynamic decompositions into a simple average. [In the price index literature, this choice is analogous to the Fisher ideal price index due to Pigou (1920) and Fisher (1922).] Thus, the weighting of the within, between (reallocation), entry, and exit effects all employ simple averages of the initial and final year weights. In addition, the ideal dynamic decomposition of the industry eliminates the covariance effect derived by Haltiwanger (1997).[4]

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which this research relies.

[3] As illustrated below, the covariance effect emerges as a consequence of the decomposition method. Our decomposition method causes the covariance effect to disappear.

[4] Griliches and Regev (1995) employ the ideal decomposition method in their study of firm productivity in Israeli industry. Scarpetta, Hemmings, Tressel, and Woo (2002) briefly describe the Griliches and Regev (1995) and Haltiwanger (1997) methods of decomposition, noting how they differ. We, however, link the differences to the base-year weighting issue.

The paper unfolds as follows. Section 2 discusses the existing dynamic decomposition and derives an alternative dynamic decomposition that when combined with the first decomposition yields the ideal dynamic decomposition. Section 3 illustrates the technique using the U.S. commercial banking industry. Section 4 extends the ideal dynamic decomposition to a state-by-state analysis – a decomposition with two components, where, on the one hand, states replace firms as the micro units to produce one component and, on the other hand, the states replace the nation as the macro unit to produce the other component. Section 5 considers how deregulation, state-level banking concentration, and the state of the state economy affect the components of the state-by-state dynamic decomposition. That analysis employs panel data estimation using the fixed- and random-effects regression techniques. Section 6 concludes.

2. Alternative Dynamic Decomposition[5]

Since we apply the ideal dynamic decomposition to the U.S. commercial banking industry as an illustration, our derivation of the various dynamic decompositions shall employ industry return on equity (ROE). The ROE at time t (R_t) equals net income (NI_t) at time t divided by equity (E_t) at time t. That is,

$$R_t = NI_t / E_t, \tag{1}$$

where $NI_t = \sum_{i=1}^{n_t} NI_{i,t}$ and $E_t = \sum_{i=1}^{n_t} E_{i,t}$. Thus, after substitution and rearrangement, we have that

$$R_t = \sum_{i=1}^{n_t} r_{i,t}\theta_{i,t} , \tag{2}$$

where $r_{i,t}$ equals the ratio of net income to equity for bank i in period t and $\theta_{i.t}$ equals the i-th bank's share of industry equity.

[5] Appendix A provides the details of the derivation.

We want to decompose the change in industry return on equity into within, between, entry, and exit effects. Thus, the change in industry return on equity equals the following:

$$\Delta R_t = R_t - R_{t-1} = \sum_{i=1}^{n_t} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}} r_{i,t-1}\theta_{i,t-1} . \quad (3)$$

Now, the number of banks in period *t* equals the number of banks in period *t-1* plus the number of bank entrants minus the number of bank exits. That is,

$$n_t = n_{t-1} + n_t^{enter} - n_{t-1}^{exit} . \quad (4)$$

Rearranging terms in equation (4) yields

$$n_t - n_t^{enter} = n_{t-1} - n_{t-1}^{exit} = n_t^{stay} \text{; or} \quad (5)$$

$$n_t = n_t^{stay} + n_t^{enter} \text{, and } n_{t-1} = n_t^{stay} + n_{t-1}^{exit} . \quad (6)$$

Note that $n_t^{stay} = n_{t-1}^{stay}$.[6] Thus, equation (3) becomes as follows:

$$\Delta R_t = \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} + \sum_{i=1}^{n_t^{enter}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} . \quad (7)$$

Case 1: *Existing Dynamic Decomposition*

So far, we have separated the "stay" terms from the "entry" and "exit" terms. Now, we need to decompose the "stay" terms into within and between effects. Bailey, Hulten, and Campbell (1992) and Haltiwanger (1997) each weight the within effect with the individual firm's industry share of equity in the initial year. That is, we need to add and subtract $\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1}$ from the right-hand side of equation (7). After some manipulation, we get that

$$\Delta R_t = \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} + \sum_{i=1}^{n_t^{enter}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} , \quad (8)$$

where $\theta_{i,\Delta t} = \theta_{i,t} - \theta_{i,t-1}$ and $r_{i,\Delta t} = r_{i,t} - r_{i,t-1}$.

[6] Consider two time periods t and (t-1). We classify banks as staying, if the bank exists in both t and (t-1); entering, if the bank does not exist in (t-1) but does in t; and exiting, if the bank exists in (t-1) but not in t.

Now, note that the sum of individual bank's shares of equity over all banks in the industry in both periods *t* and *t-1* equals one. That is,

$$\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + \sum_{i=1}^{n_t^{enter}} \theta_{i,t} = \sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} + \sum_{i=1}^{n_{t-1}^{exit}} \theta_{i,t-1} = 1 . \tag{9}$$

Consequently, we can say that

$$R_{t-1}\left[\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + \sum_{i=1}^{n_t^{enter}} \theta_{i,t}\right] - R_{t-1}\left[\sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} + \sum_{i=1}^{n_{t-1}^{exit}} \theta_{i,t-1}\right] = 0 . \tag{10}$$

Finally, adding the left-hand side of equation (10), which equals zero, to equation (8) produces after some algebraic manipulation the following relation:

$$\Delta R_t = \underbrace{\sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\,\theta_{i,t-1}}_{\text{“within effect”}} + \underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t} - R_{t-1})\theta_{i,\Delta t}}_{\text{“between effect”}} + \underbrace{\sum_{i=1}^{n_t^{enter}} (r_{i,t} - R_{t-1})\theta_{i,t}}_{\text{“entry effect”}}$$

$$\underbrace{-\sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_{t-1})\theta_{i,t-1}}_{\text{“exit effect”}} . \tag{11}$$

Haltiwanger (1997) decomposes the between (reallocation) effect into a "share" effect and a "covariance" effect by adding and subtracting $r_{i,t-1}$ within the term $(r_{i,t} - R_{t-1})$ contained in the between effect summation.[7] That generates the following result:

$$\underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t} - R_{t-1})\theta_{i,\Delta t}}_{\text{“between effect”}} = \underbrace{\sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,\Delta t}}_{\text{“covariance effect”}} + \underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_{t-1})\theta_{i,\Delta t}}_{\text{“share effect”}} . \tag{12}$$

As shown below, the covariance effect disappears from the ideal dynamic decomposition.[8]

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[7] Stiroh (1999) further decomposes the within, share, and covariance effects into effects for banks that acquire other banks and banks that do not.

[8] An alternative decomposition (*Case 1a*) uses the industry return on equity in period *t* (R_t) instead of in period *t-1* (R_{t-1}) in equation (10) and subsequent derivations. The dynamic decomposition equals equation (11) where the current period industry return on equity (R_t) replaces the previous period industry return on equity (R_{t-1}) everywhere. Thus, the covariance term identified by Haltiwanger (1997) does not appear, since the base industry return on equity is the current period rather than the previous period.

Case 2: Alternative Dynamic Decomposition

Now, decompose the change in industry return on equity by weighting the within effect by period-t individual bank's share of industry equity. That is, we need to add and subtract $\sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t}$ to equation (7). Then follow the same procedures used in the first dynamic decomposition where the industry return on equity in period t (R_t) replaces the industry return on equity in period t-1 (R_{t-1}) in equation (10). After the necessary manipulations, the final form is as follows:

$$\Delta R_t = \underbrace{\sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t}}_{\text{"within effect"}} + \underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_t)\theta_{i,\Delta t}}_{\text{"between effect"}} + \underbrace{\sum_{i=1}^{n_t^{enter}} (r_{i,t} - R_t)\theta_{i,t}}_{\text{"entry effect"}}$$

$$- \underbrace{\sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t)\theta_{i,t-1}}_{\text{"exit effect"}} . \tag{13}$$

Now, we can further decompose the between (reallocation) effect by adding and subtracting $r_{i,t}$ inside the term $(r_{i,t-1} - R_t)$ contained in the between summation and generate the following result:[9]

$$\underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_t)\theta_{i,\Delta t}}_{\text{"between effect"}} = \underbrace{-\sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,\Delta t}}_{\text{-"covariance effect"}} + \underbrace{\sum_{i=1}^{n_t^{stay}} (r_{i,t} - R_t)\theta_{i,\Delta t}}_{\text{"share effect"}} \tag{14}$$

Case 3: Ideal Dynamic Decomposition

The ideal dynamic decomposition simply averages the *Case 1* and *Case 2* dynamic

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[9] Similar to *Case 1*, an alternative dynamic decomposition (*Case 2a*) uses the industry return on equity in period t-1 (R_{t-1}) instead of in period t (R_t). That is, use the original equation (10). Now, the dynamic decomposition equals equation (13) where the industry return on equity in period t-1 (R_{t-1}) replaces the industry return on equity in period t (R_t) everywhere. And again, no covariance term emerges from this dynamic decomposition.

decompositions yielding the following:[10]

$$\Delta R_t = \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\bar{\theta}_i + \sum_{i=1}^{n_t^{stay}} (\bar{r}_i - \bar{R})\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{enter}} (r_{i,t} - \bar{R})\theta_{i,t}$$

"within effect" *"between effect"* *"entry effect"*

$$-\sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - \bar{R})\theta_{i,t-1} \ . \tag{15}$$

"exit effect"

where $\bar{\theta}_i = (\theta_{i,t} + \theta_{i,t-1})/2$,

$\bar{r}_i = (r_{i,t} + r_{i,t-1})/2$, and

$\bar{R} = (R_t + R_{t-1})/2$.

In sum, the ideal dynamic decomposition includes four effects. The within effect equals the summation of each bank's change in return on equity weighted by its average share of industry equity between period *t* and *t-1*. The between (reallocation) effect equals the summation of the difference between each bank's return on equity and the average industry return on equity between periods *t* and *t-1* times the change in that bank's share of industry equity. The entry effect equals the summation of the difference between each entry bank's return on equity in period *t* and the average industry return on equity between periods *t* and *t-1* times the entry bank's share of industry equity in period *t*. Finally, the exit effect equals the summation of the difference between each exit bank's return on equity in period *t-1* and the average industry return on equity between periods *t* and *t-1* times the exit bank's share of industry equity in period *t-1*.

3. Commercial Bank Return on Equity: Nationwide Decomposition

To illustrate the ideal dynamic decomposition, we employ Call Report data for all commercial

[10] The same result emerges if we average the dynamic decompositions in *Case 1a* and *Case 2a*.

banks in the U.S. from 1976 to 2000.[11] To calculate the dynamic decomposition between two years, say 1999 and 2000, we need to identify and separate entrants (banks that entered the industry), exits (banks that exited the industry), and stays (banks that stayed in the industry). To do so, we matched bank ID numbers in the database. If a bank ID number exists in both 1999 and 2000, then the bank stays in the industry. If a bank ID number exists in 1999, but not in 2000, then the bank exits the industry. If a bank ID number exists in 2000, but not in 1999, then the bank enters the industry.

Table 1 provides the dynamic decomposition of aggregate return on equity for all commercial banks in the U.S. between 1976 and 2000. Several observations emerge. First, on a year-to-year basis, the within effect explains the change in return on equity. The correlations between the within, between, entry, and exit effects and the change in return on equity equal 0.92, -0.12, 0.02, and –0.30, respectively. Further, simple ordinary least squares regressions of the change in return on equity onto the within, between, entry, and exit effects only produce a significant regression for the within effect. The within effect, however, does not contribute much to the cumulative, long-run change in return on equity, as we show below.[12]

Second, the entry effect contributes negatively to industry return on equity in each and every year. That is, entrants to the banking industry, on average, experience a return on equity below the average return on equity in the market. Thus, entry lowers industry return on equity, which is not a surprise. DeYoung and Hasan (1998) and DeYoung (1999) note that bank entrants generally are small banks that require several years before they experience a return on equity

[11] The data for our analysis come from the Federal Reserve Bank of Chicago web site, which is located at http://www.chicagofed.org/economicresearchanddata/data/bhcdatabase/bhcdatabase.cfm.

[12] The significant regression generates an intercept of 0.00, which is not significantly different from zero at the 1-percent level, and a slope coefficient of 0.83, which is significantly less than one at the 5-, but5 not the 10-, percent

comparable to the industry average, assuming that they survive.

Third, the exit effect improves industry return on equity between each pair of years, save one, 1999 to 2000. That is, exits from the banking industry, on average, experience a return on equity below the industry average. That finding is also not a surprise. For example, Stiroh and Strahan (1999) argue that after deregulation, exiting banks merged into banks that were better run, more profitable banks, on average. Our results suggest that such an outcome was not only true, on average, after deregulation, but also true before deregulation. Finally, it was only between 1999 and 2000 that exiting banks, on average, were more profitable than the industry average.

Fourth, the between (reallocation) effect contributed positively to increasing the industry return on equity in 19 out of the 24 years in our sample. In addition, between 1980 and 1992, the between (reallocation) effect increased industry return on equity for 13 consecutive years. From 1993 to 2000, the contribution of the between (reallocation) effect provided 4 positive and 4 negative years. Prior to 1992 mergers and acquisitions exhibited more intrastate activity, while it was only after 1992 that interstate merger and acquisitions became a larger part of the overall story. Moreover, interstate mergers and acquisitions generally involve much bigger banks. Our findings, therefore, hint that intrastate mergers and acquisitions contributed more to improved industry performance than did interstate mergers and acquisitions. That conjecture, however, needs much more analysis before it can be claimed with any degree of certainty. At the moment, that observation is only suggestive.

Finally, the dynamic decomposition that covers the 1976 to 2000 period merely reflects the summation of the year-by-year effects. That is, the aggregate, long-run within, between

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level.

(reallocation), entry, and exit effects totaled –0.0072, 0.0451, -0.0459, and –0.0566, respectively. Viewed differently, the average effects over the 25-year period are –0.0003, 0.0019, -0.0019, and –0.0024, respectively. Thus, the change in industry return on equity of 0.0487 between 1976 and 2000 reflects the positive contributions of the between and exit effects.[13] Moreover, the entry effect offsets completely the between effect, while the within effect, although negative, is small. Thus, the increase in the industry return on equity between 1976 and 2000 falls just below in aggregate the positive contribution of the exit effect. To emphasize an important point, the within effect proves important in understanding year-to-year, short-run changes in return on equity, but unimportant in understanding cumulative, long-run changes.

4. Dynamic Decomposition with Geographic Aggregation

Our discussion so far considers how to decompose some industry measure of performance based on the contributions to that performance of individual firms, in our example commercial banks. The regulation of banking in the U.S. provides some interest in data aggregated to the state, rather than the national, level. In fact, although not used in this study, the Federal Deposit Insurance Corporation makes much state-level data available on their web site (http://www2.fdic.gov/hsob). That is, banking raises the possibility of examining performance of the industry at the state level. Such considerations lead to two extensions of our decomposition analysis – (i) decompose national performance measures using the state, rather than the firm, as the micro unit of analysis; and (ii) decompose state-level performance measures using the firm as the micro unit of analysis.

[13] Note that the exit effect, while negative, contributes positively to the change in industry return on equity, since it enters the dynamic decomposition with a negative sign.

National Decomposition: State as the Micro Unit[14]

We start, once again, with equation (1). That is,

$$R_t = NI_t / E_t, \tag{1}$$

where we now index net income and equity across states and banks. Thus, we now have that $\sum_{s=1}^{S}\sum_{i=1}^{n_s} NI_{i,s,t}$ and $\sum_{s=1}^{S}\sum_{i=1}^{n_s} E_{i,s,t}$, where $NI_{i,s,t}$ and $E_{i,s,t}$ equal net income and equity for bank i in state s and period t, and S (=51) and n_s equal the number of states (including the District of Columbia) and the number of banks within state s.

Thus, substituting and rearranging yields the following:

$$R_t = \sum_{s=1}^{S}\theta_{s,t}\sum_{i=1}^{n_s} r_{i,s,t}\theta_{i,s,t} \ , \tag{16}$$

where $r_{i,s,t}$ equals the ratio of net income to equity for bank i in state s and period t and $\theta_{i.s,t}$ equals the i-th bank's share of industry equity in state s and period t. Now, the second summation in equation (16) equals the return on equity in state s. That is, we have that

$$R_{s,t} = \sum_{i=1}^{n_s} r_{i,s,t}\theta_{i,s,t} \ . \tag{17}$$

Therefore,

$$R_t = \sum_{s=1}^{S}\theta_{s,t}R_{s,t} \ . \tag{18}$$

Following the same procedural steps outlined above for the decomposition of the change in return on equity at the national level, but now using that state aggregates as the micro units, we can easily derive the following relationship:

[14] Appendix B provides the complete derivation.

$$\Delta R_t = \sum_{s=1}^{S} \bar{\theta}_s R_{s,\Delta t} \quad + \sum_{s=1}^{S} \theta_{s,\Delta t} \left[\bar{R}_s - \bar{R} \right], \tag{19}$$

"within effect" *"between effect"*

where $\bar{\theta}_s = (\theta_{s,t} + \theta_{s,t-1})/2$,

$\bar{R}_s = (R_{s,t} + R_{s,t-1})/2$, and

$\bar{R} = (R_t + R_{t-1})/2$.

No entry or exit effects exist in the decomposition, since states do not enter or exit. The entry and exit effects in the national decomposition will appear in the decomposition of the state-level change in return on equity $R_{s,\Delta t}$ that we discuss in the next sub-section. Also, note that equation (17) reports the ideal dynamic decomposition (case 3) that averages the case-1 and case-2 decompositions. And in the process, the covariance term reported by other authors disappears.

Table 1 also reports the decomposition in equation (19) for the 1976 to 2000 sample period. Several observations stand out. First, once again, the within effect dominates the between effect on a year-by-year basis. The sign of the within effect matches the sign of the change in the return on equity each year, except between 1993 and 1994 when the change in return on equity essentially equals zero. In addition, the within effect equals 114 percent of the change in return on equity, on average, excluding 1994. The correlations between the within and between effects and the change in return on equity equal 0.997 and –0.04. Finally, simple ordinary least squares regressions of the change in return on equity onto, in turn, the within and between effects only yields a significant regression for the within effect.[15]

Second, while the summation of the individual within effects and the change in return on

[15] That regression produces a constant of 0.00, which is not significantly different from zero at the 1-percent level,

equity equal 0.0239 and 0.0487, respectively, the year-by-year values exceed zero only 9 and 10 times out of the 24 yearly observations. That is, the positive values must generally exceed the negative values by sufficient amount to yield an overall positive outcome.

Finally, the between effect exceeds zero 20 out of 24 years. Moreover, although the between effect generally equals a smaller fraction of the change in the return on equity than the within effect, its accumulated value over the 24 years matches the within effect in magnitude. That is, on average, the within and between effects contributed about half of the cumulative, long-run change in return on equity.

State-Level Decomposition: Bank as the Micro Unit

This section decomposes the change in return on equity at the state level, $R_{s,\Delta t}$. The process of deriving the decomposition follows the same outline that we followed in Section 2, except that the return on equity at the state level replaces the return on equity for the nation. After carrying out the required manipulations, we come to the following decomposition:

$$R_{s,\Delta t} = \underbrace{\sum_{i=1}^{n_{s,t}^{stay}} r_{i,s,\Delta t}\bar{\theta}_{i,s}}_{\text{"within effect"}} + \underbrace{\sum_{i=1}^{n_{s,t}^{stay}} (\bar{r}_{i,s} - \bar{R}_s)\theta_{i,s,\Delta t}}_{\text{"between effect"}} + \underbrace{\sum_{i=1}^{n_{s,t}^{enter}} (r_{i,s,t} - \bar{R}_s)\theta_{i,s,t}}_{\text{"entry effect"}}$$

$$- \underbrace{\sum_{i=1}^{n_{s,t-1}^{exit}} (r_{i,s,t-1} - \bar{R}_s)\theta_{i,s,t-1}}_{\text{"exit effect"}}. \tag{20}$$

where $\bar{\theta}_{i,s} = (\theta_{i,s,t} + \theta_{i,s,t-1})/2$,

$\bar{r}_{i,s} = (r_{i,s,t} + r_{i,s,t-1})/2$, and

$\bar{R}_s = (R_{s,t} + R_{s,t-1})/2$.

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and a slope coefficient of 0.99, which is not significantly different from one at the 1-percent level.

Equation (20) reports only the ideal dynamic decomposition (case 3) that averages the case-1 and case-2 dynamic decompositions. Once again, the covariance term reported by other authors disappears.

Table 2 reports the summations and averages of the decompositions over the 24-year period for each state.[16] Once again, several items deserve notice. First, the entry effect falls below zero, on average, in every state except Minnesota. That is, on average, over the whole 24-year sample period, Minnesota experienced bank entrants that earned a return on equity that exceeded the average of all banks in Minnesota when those banks entered. New banks typically exhibit small size and generally low performance, at least for the first few years. Thus, Minnesota bucked the trend in this particular area.

Second, the exit effect falls below zero, on average, in 40 of the 51 states. The 11 exceptions – Arkansas, District of Columbia, Georgia, Iowa, Idaho, Indiana, Louisiana, Michigan, Missouri, South Carolina, and West Virginia – each experienced, on average, bank exits with a higher return on equity than the average of all banks in the state when those banks exited. Typically when banks exit, some other bank acquires that banks assets and liabilities. That is, the exit associates with a take-over or merger. A take-over and merger where the exiting bank exhibits higher than average performance would generate a positive exit effect.

Third, the average within effect exceeds the average between effect over all states and time. That finding reverses the finding at the national level where the between effect exceeded the within effect, on average. How is this possible? Well, note that the within and between effects exhibit the identical effect in magnitude for the dynamic decomposition of the national return on equity where the state is micro unit of analysis. Thus, the shifting of assets between

[16] The year-by-year results for all states are available from the authors on request.

banks achieves more importance at the national level because of more uneven growth of assets between states than between banks within a given state.

Fourth, the within effect exceeds zero for 37 of the 51 states. A negative within effect implies that banks' performance deteriorate, on average. The 14 states with a negative within effect include Alaska, Connecticut, Massachusetts, Maine, Minnesota, Montana, Nebraska, New Jersey, New York, Oklahoma, Pennsylvania, Texas, Vermont, and Washington.

Finally, the between effect exceeds zero in 39 of the 51 states. A negative between effect implies that assets shifted from higher- to lower-performance banks in a state. The 12 states with a negative between effect include Arizona, the District of Columbia, Georgia, Hawaii, Idaho, Illinois, Maryland, Maine, Mississippi, Oregon, South Dakota, and Utah.

Close inspection of Table 2 reveals potential anomalous findings for the within and between effects – especially Alaska and Arizona, and possibly Hawaii. The within and between effects each possess large values with opposite signs. Examination of the year-by-year, state-by-state information yields the following explanation. In all three instances, a dramatic drop in equity occurs for one bank in each state between two years – 1985 to 1986 in Alaska, 1998 to 1999 in Arizona, and 1994 to 1995 in Hawaii – but no similar decline in income, expenses, and thus net income. Thus, the return on equity shoots up in magnitude for one bank in one year in each of those three states -- -12,717.3 percent in Alaska in 1986, 5,720.7 percent in Arizona in 1999, and 1,630.6 percent in Hawaii in 1995. The resultant contribution to the aggregate within and between effects exceeded 90 percent in each case. In addition, the banks in question exited the industry the following year in Alaska and Arizona, but not in Hawaii. The bank in Hawaii did not exit in 1996. It still operated with lower equity but now also experienced lower income, expenses, and net income. The contribution to the within and between effects in Hawaii in 1996 when both net income and equity experience much lower levels no longer possesses a large effect, because the weighting factor now averages much smaller weights in 1995 and 1996.[17]

5. Explaining State-by-State Dynamic Decomposition

Differences in bank performance across states may reflect differences in bank concentration in each state, differences in the regulatory environment in each state, and differences in the state of the economy in each state. Moreover, those state-by-state differences may affect the different components of the dynamic decomposition differently – the within, between, entry, and exit effects. We explore such differences through the application of panel data fixed- and random-effects regression estimates.

We calculate the decomposition on a state-by-state basis, computing the within, between, entry and exit effects for each state over the 1976 to 2000 period in this paper. We collected other variables to capture concentration, regulatory, and economic effects. We measure concentration in banking (*top5*) with the percent of assets held by the top-5 banks in each state. Several variables capture the regulatory stance of states with respect to mergers and acquisitions. One, the ratio of branches to banks (*brn_bn*) measures the effective regulatory stance in the state with respect to branching.[18] In addition, three dummy variables specify the regulatory stance in each state vis-à-vis bank mergers through multibank holding companies. A state could allow out-of-state bank holding companies to acquire banks within its borders with or without conditions (reciprocity). For example, some states allow bank holding companies from other states to

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[17] Hadi (1992, 1994) develops methods for determining multiple outliers in multivariate data. Applying that methodology to our data set for the within and between effects identifies five additional outliers where the within and between effects experience nearly equal magnitudes greater than 0.2 and opposite signs – Massachusetts between 1990 and 1991, Texas between 1987 and 1988, Indiana between 1982 and 1983, and 1983 and 1984, and Missouri between 1982 and 1983 in order of importance according to Hadi's procedure.

[18] Many studies include dummy variables for unit, limited, and statewide branching regulation. Kaparakis, Miller, and Noulas (1994) use the ratio of branches to banks to categorize states into these three categories. We use the

acquire a bank within its borders only for the set of states that also allow bank holding companies from this state to acquire banks within their borders. All such regulations became abrogated with the passage of the Interstate Banking and Branching efficiency Act of 1994, which permitted bank holding company operations on a national basis without geographic restrictions. The first dummy variable (*regid*) is one if a state possesses regional reciprocity, zero otherwise; the second (*nation*) is one if a state possesses national reciprocity, zero otherwise; and the third (*non*) is one is a state possesses national non-reciprocity, zero otherwise.[19] Finally, state-level economic information includes the unemployment rate (*unem*).

Table 3 reports the results of the panel-data fixed- and random-effects estimation.[20] Moreover, we perform the Hausman test to select the fixed- or random-effects model. The dependent variables included the within, between, entry, and exit effects. For the within- and between-effects regressions, the random-effects-model proves the superior choice while for the entry- and exit-effect regressions the fixed-effects model dominates.

Several observations deserve notice. First, the within and between effects significantly respond to the state of the economy, but not to the concentration or regulatory variables. If the state economy improves (i.e., lower unemployment rate), then the within effect increases, suggesting that the performance of each bank, on average, improves. On the other hand, a worsening economy (i.e., a higher unemployment rate) causes the performance of the average bank in a state to improve as banks with above average performance tend to increase their

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actual ratio of branches to banks to capture the branching regulatory effect.

19 Amel (1993) provides the initial specification for the three dummy variables. Daniels and Tirtirogul (1998) updated Amel's specification through 1995. We extend the dummy variables to 2000, where national non-reciprocity was legislated to become effective in September 1995 as noted in the text.

20 We also performed the fixed- and random-effects estimations excluding all observations with both the within and between effects greater than 0.2 in absolute value. The findings did not differ qualitatively from those reported in the text. Results are available on request.

market share.

Second, the entry and exit effects significantly respond to higher concentration. The more concentrated a state is, the higher the entry effect is and the lower the exit effect is. That is, in more concentrated states, banks that enter tend to perform better and banks that exit tend to perform worse than banks that enter and exit in less concentrated states.

Finally, states with a high ratio of branches to banks (i.e., rather permissive state branching regulation), on average, experience a larger exit effect. That means that those banks that do exit will exhibit higher performance. Conversely, states that permitted bank holding company operations within its borders without reciprocity see, on average, a lower exit effect, implying that those banks that do exit exhibit lower performance.

6. Conclusion

The deregulation of the U.S. banking industry over the past quarter century affected bank operations and performance in important ways. We consider the dynamic decomposition of the return on equity aggregated first to the national level and then to the state level. Further, we consider the effects of deregulation of geographic restrictions as well as banking concentration and the state of the economy on a state-by-state basis on bank operations.

The recent availability of micro (plant-level) data on manufacturing firms generated a series of papers that consider the decomposition of industry performance measures such as total factor productivity into components due to within, between, entry and exit effects (Bailey, Hulten, and Campbell 1992, Haltiwanger 1997, and included references). To date, the standard dynamic decomposition calculates the within effect based on individual firm's industry shares in the initial period.[21] Analogous to construction of price indexes, we derive a similar dynamic

[21] We note in footnote 4 that Griliches and Regev (1995) employ the ideal decomposition and that Scarpetta,

decomposition where the within effect is weighted by the individual firm's industry share in the final period, rather than the initial period. Moreover, the ideal dynamic decomposition emerges when we average those two alternative dynamic decompositions.

Haltiwanger (1997) divides the between effect of the standard dynamic decomposition into share and covariance effects. We demonstrate that the covariance effect represents an artifact of the standard dynamic decompositions (*Case 1*) – the use of the initial firm's industry share to weight the within effect. An alternative dynamic decomposition (*Case 2*) that weights the within effect by the firm's industry share in the final period produces a covariance effect, but with the opposite sign. As a result, our ideal dynamic decomposition, the average of the two alternative decompositions, does not contain the covariance effect.[22]

We apply our ideal dynamic decomposition to the return on equity in the commercial banking industry between 1976 and 2000 where the microeconomic unit is the bank.[23] We find that the between and exit effects contributed positively and strongly to the banking industry's return on equity. The entry effect also contributed negatively and strongly to industry return on equity. But the within effect, although negative, did not contribute much to the change in industry return on equity. Interestingly, although the within effect does not contribute to the cumulative, long-run change in return on equity over the sample period, the within effect dominates the between, entry, and exit effects on a year-to-year basis.

Next, we apply the ideal dynamic decomposition to the return on equity in the

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Hemmings, Tressel, and Woo (2002) briefly describe how the Griliches and Regev (1995) and Haltiwanger (1997) methods differ.

[22] In fact, two additional dynamic decompositions (*Cases 1a and 2a*) do not possess a covariance term in the first place. Stiroh (1999) extends Haltiwanger's (1997) method by differentiating between those banks that acquire other banks and those that do not.

[23] Unlike manufacturing industry micro data, we do not have information at the branch level that would correspond to the plant level for manufacturing firms.

commercial banking industry where the microeconomic unit is the state. Now, the entry and exit effects lose any practical meaning. Here, the within and between effects exhibit some interesting patterns. The within effect in any given year again dominates the between effect in its effect on the change in state return on equity. The between effect, although seemingly insignificant each year, produces a significant effect on the change in return on equity over the long run, reaching parity with the within effect over the entire 25-year sample period..

Then, we apply the ideal dynamic decomposition on a state-by-state basis where the microeconomic unit is the bank. Here, the cumulative, long-run within effect in each state dominates the between effect. That is, the between effect possesses more clout, on average, between banks in different states than between banks in the same state.

Finally, we employ our state-by-state decompositions to perform panel-data fixed- and random-effects regressions of the components of the decomposition onto bank concentration, bank regulation, and state economic variables. The within and between effects respond to the state of the economy and do not respond to bank concentration and regulation. The entry and exit effects do not respond to the state of the economy, but do respond to bank concentration and bank regulation. A worsening state economy will, on average, see a lower within effect and a higher between effect. Higher bank concentration will see, on average, a higher entry effect and a lower exit effect.

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Table 1: Dynamic Decomposition of U.S. Banking Industry: 1976-2000

YEAR	WITHIN	BETWEEN	ENTRY	EXIT	ΔROE	ST_WTHN	ST_BTWN
1976-1977	0.0101	0.0010	-0.0006	-0.0004	0.0108	0.0108	0.0000
1977-1978	0.0231	0.0013	-0.0011	-0.0006	0.0239	0.0235	0.0005
1978-1979	-0.0704	-0.0008	-0.0008	-0.0003	-0.0717	-0.0716	0.0000
1979-1980	-0.0147	0.0043	-0.0006	-0.0002	-0.0107	-0.0117	0.0010
1980-1981	-0.0227	0.0053	-0.0014	-0.0020	-0.0168	-0.0182	0.0014
1981-1982	-0.0298	0.0114	-0.0012	-0.0029	-0.0167	-0.0177	0.0010
1982-1983	-0.0075	0.0019	-0.0011	-0.0020	-0.0048	-0.0054	0.0006
1983-1984	0.0738	0.0064	-0.0016	-0.0047	0.0832	0.0830	0.0002
1984-1985	0.0150	0.0013	-0.0014	-0.0004	0.0152	0.0148	0.0004
1985-1986	-0.0226	0.0123	-0.0015	-0.0111	-0.0007	-0.0006	-0.0001
1986-1987	0.0164	0.0046	-0.0014	-0.0019	0.0215	0.0184	0.0032
1987-1988	-0.0008	0.0149	-0.0022	-0.0027	0.0145	0.0118	0.0027
1988-1989	0.0029	0.0019	-0.0120	-0.0023	-0.0049	-0.0066	0.0016
1989-1990	-0.0158	0.0023	-0.0020	-0.0007	-0.0149	-0.0174	0.0025
1990-1991	-0.0218	0.0177	-0.0003	-0.0017	-0.0027	-0.0026	-0.0001
1991-1992	0.0156	0.0017	-0.0006	-0.0010	0.0178	0.0179	0.0000
1992-1993	-0.0066	-0.0022	-0.0010	-0.0028	-0.0070	-0.0057	-0.0013
1993-1994	-0.0038	0.0013	-0.0003	-0.0029	0.0000	-0.0012	0.0012
1994-1995	0.0003	-0.0041	-0.0011	-0.0010	-0.0039	-0.0048	0.0009
1995-1996	0.0024	0.0010	-0.0093	-0.0029	-0.0030	-0.0100	0.0070
1996-1997	0.0046	0.0028	-0.0005	-0.0082	0.0151	0.0188	-0.0037
1997-1998	-0.0150	-0.0019	-0.0009	-0.0001	-0.0176	-0.0179	0.0003
1998-1999	0.0720	-0.0435	-0.0017	-0.0047	0.0315	0.0294	0.0021
1999-2000	-0.0119	0.0043	-0.0012	0.0007	-0.0095	-0.0131	0.0036
SUM	-0.0072	0.0451	-0.0459	-0.0566	0.0487	0.0239	0.0248
AVE	-0.0003	0.0019	-0.0019	-0.0024	0.0020	0.0010	0.0010

Note: The change in return on equity between any two years (e.g., ΔROE between 1999 and 2000 equals –0.0095 = 0.2599 – 0.2694) equals the sum of the WITHIN, BETWEEN, and ENTRY effects minus the EXIT effect (e.g., -0.0119 + 0.0043 – 0.0012 – 0.0007 = -0.0095). It also equals the sum of the state within (ST_WTHN) and state between (ST_BTWN) effects.

Table 2: State-by-State Dynamic Decomposition of U.S. Banking Industry: 1976-2000

	SUMMATION				AVERAGE			
	WITHIN	BETWEEN	ENTRY	EXIT	WITHIN	BETWEEN	ENTRY	EXIT
Alabama	0.0559	0.0572	-0.0198	-0.0229	0.0023	0.0024	-0.0008	-0.0010
Alaska	-4.2136	3.7726	-0.0088	-0.2701	-0.1756	0.1572	-0.0004	-0.0113
Arizona	5.8222	-5.4452	-0.1142	-0.0504	0.2426	-0.2269	-0.0048	-0.0021
Arkansas	0.0606	0.0140	-0.0160	0.0246	0.0025	0.0006	-0.0007	0.0010
California	0.0041	0.0468	-0.0413	-0.0429	0.0002	0.0019	-0.0017	-0.0018
Colorado	0.0667	0.0392	-0.0515	-0.0630	0.0028	0.0016	-0.0021	-0.0026
Connecticut	-0.4477	0.1084	-0.0701	-0.0554	-0.0187	0.0045	-0.0029	-0.0023
Delaware	0.0702	0.0461	-0.2844	-0.2737	0.0029	0.0019	-0.0119	-0.0114
D. Columbia	0.0678	-0.0143	-0.0339	0.0490	0.0028	-0.0006	-0.0014	0.0020
Florida	0.1292	0.0407	-0.0954	-0.0430	0.0054	0.0017	-0.0040	-0.0018
Georgia	0.2546	-0.0342	-0.0409	0.0044	0.0106	-0.0014	-0.0017	0.0002
Hawaii	0.7731	-0.6665	-0.0108	-0.0242	0.0322	-0.0278	-0.0004	-0.0010
Idaho	0.1027	-0.0313	-0.0693	0.0189	0.0043	-0.0013	-0.0029	0.0008
Illinois	0.0657	-0.0338	-0.0223	-0.0245	0.0027	-0.0014	-0.0009	-0.0010
Indiana	0.0127	0.0346	-0.0113	0.0049	0.0005	0.0014	-0.0005	0.0002
Iowa	0.0096	0.0234	-0.0102	0.0082	0.0004	0.0010	-0.0004	0.0003
Kansas	0.0320	0.0504	-0.0150	-0.0094	0.0013	0.0021	-0.0006	-0.0004
Kentucky	0.0224	0.0337	-0.0185	-0.0211	0.0009	0.0014	-0.0008	-0.0009
Louisiana	0.0343	0.0789	-0.0209	-0.0010	0.0014	0.0033	-0.0009	0.0000
Maine	-0.2481	-0.0014	-0.0574	-0.0633	-0.0103	-0.0001	-0.0024	-0.0026
Maryland	0.0252	-0.0096	-0.0288	-0.0473	0.0010	-0.0004	-0.0012	-0.0020
Massachusetts	-0.3362	0.3453	-0.0929	-0.0848	-0.0140	0.0144	-0.0039	-0.0035
Michigan	0.1562	0.0061	-0.0206	0.0013	0.0065	0.0003	-0.0009	0.0001
Minnesota	-0.0862	0.1166	0.0024	-0.0440	-0.0036	0.0049	0.0001	-0.0018
Mississippi	0.2238	-0.1712	-0.0151	-0.0197	0.0093	-0.0071	-0.0006	-0.0008
Missouri	0.0896	0.0258	-0.0098	0.0271	0.0037	0.0011	-0.0004	0.0011
Montana	-0.0055	0.0578	-0.0231	-0.0267	-0.0002	0.0024	-0.0010	-0.0011
Nebraska	-0.0345	0.0172	-0.0113	-0.0740	-0.0014	0.0007	-0.0005	-0.0031
Nevada	0.4834	0.0048	-0.1115	-0.0694	0.0201	0.0002	-0.0046	-0.0029
New Hampshire	0.1259	0.2036	-0.1058	-0.2689	0.0052	0.0085	-0.0044	-0.0112
New Jersey	-0.0128	0.0020	-0.0484	-0.0257	-0.0005	0.0001	-0.0020	-0.0011
New Mexico	0.0450	0.0323	-0.0516	-0.0027	0.0019	0.0013	-0.0022	-0.0001
New York	-0.1960	0.0834	-0.0493	-0.0619	-0.0082	0.0035	-0.0021	-0.0026
North Carolina	0.1023	0.0079	-0.0398	-0.0290	0.0043	0.0003	-0.0017	-0.0012
North Dakota	0.0293	0.0660	-0.0100	-0.0071	0.0012	0.0027	-0.0004	-0.0003
Ohio	0.1611	0.0050	-0.0212	-0.0290	0.0067	0.0002	-0.0009	-0.0012
Oklahoma	-0.0714	0.1067	-0.0243	-0.0378	-0.0030	0.0044	-0.0010	-0.0016
Oregon	0.2020	-0.0964	-0.1225	-0.0280	0.0084	-0.0040	-0.0051	-0.0012
Pennsylvania	-0.0457	0.0637	-0.0333	-0.0495	-0.0019	0.0027	-0.0014	-0.0021
Rhode Island	0.0963	0.0403	-0.0688	-0.0098	0.0040	0.0017	-0.0029	-0.0004
South Carolina	0.1947	0.0107	-0.0494	0.0544	0.0081	0.0004	-0.0021	0.0023

Table 2: State-by-State Dynamic Decomposition of U.S. Banking Industry: 1976-2000 (continued)

	SUMMATION				AVERAGE			
	WITHIN	BETWEEN	ENTRY	EXIT	WITHIN	BETWEEN	ENTRY	EXIT
South Dakota	0.6880	-0.0942	-0.1084	-0.0615	0.0287	-0.0039	-0.0045	-0.0026
Tennessee	0.0387	0.0746	-0.0306	-0.0545	0.0016	0.0031	-0.0013	-0.0023
Texas	-0.4211	0.4444	-0.0351	-0.0953	-0.0175	0.0185	-0.0015	-0.0040
Utah	0.3434	-0.1206	-0.0873	-0.0248	0.0143	-0.0050	-0.0036	-0.0010
Vermont	-0.2834	0.1131	-0.0273	-0.0854	-0.0118	0.0047	-0.0011	-0.0036
Virginia	0.1873	0.1197	-0.0431	-0.1027	0.0078	0.0050	-0.0018	-0.0043
Washington	-0.1120	0.0577	-0.0176	-0.0059	-0.0047	0.0024	-0.0007	-0.0002
West Virginia	0.0292	0.0570	-0.0221	0.0240	0.0012	0.0024	-0.0009	0.0010
Wisconsin	0.0274	0.0132	-0.0206	-0.0189	0.0011	0.0006	-0.0009	-0.0008
Wyoming	0.0062	0.0611	-0.0412	-0.1120	0.0003	0.0025	-0.0017	-0.0047
AVERAGE	0.0848	-0.0047	-0.0467	-0.0436	0.0035	-0.0002	-0.0019	-0.0018
ST. DEV.	1.0372	0.9474	0.0468	0.0680	0.0432	0.0395	0.0020	0.0028

Note: The SUMMATION equals the sum across all years for a given state while the AVERAGE equals the SUMMATION divided by 24.

Table 3: Panel Fixed- and Random-Effects Regressions of Decomposition Components

	Variable	Within Effect		Between Effect		Entry Effect		Exit Effect	
		Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Fixed-Effects Model (FE)	**top5**	0.0002	0.32	-0.0001	-0.19	0.0001**	2.55	-0.0001*	-3.38
	bch_bn	0.0018	0.66	-0.0007	-0.29	-0.0001	-0.80	0.0006*	4.17
	regid	-0.0041	-0.21	0.0054	0.29	-0.0015	-1.95	-0.0009	-0.80
	non	-0.0208	-0.98	0.0111	0.55	-0.0015	-1.94	-0.0030*	-2.57
	nation	-0.0157	-0.71	0.0069	0.33	-0.0003	-0.39	-0.0001	-0.11
	unem	-0.0078	-1.89	0.0060	1.53	0.0002	1.52	-0.0004	-1.76
Random-Effects Model (RE)	**top5**	0.0003	0.72	-0.0001	-0.38	0.0000	-0.25	-0.0001*	-2.72
	bch_bn	0.0009	0.71	-0.0010	-0.94	0.0000	-0.87	0.0002*	2.79
	regid	-0.0078	-0.43	0.0104	0.61	-0.0009	-1.34	-0.0001	-0.14
	non	-0.0193	-1.17	0.0144	0.93	-0.0009	-1.36	-0.0017	-1.85
	nation	-0.0144	-0.72	0.0085	0.46	-0.0003	-0.35	0.0004	0.35
	unem	-0.0078**	-2.52	0.0061**	2.11	0.0002	1.85	-0.0001	-0.75
	constant	0.0404	1.52	-0.0304	-1.23	-0.0024**	-2.22	0.0010	0.64
Hausman Test	**$\chi^2(6)$**	1.11		0.88		12.71		24.09	
	p-value	0.9813		0.9897		0.0479		0.0005	
	Decision	RE		RE		FE		FE	

Note: The dependent variables are the within, between, entry, and exit effects. The independent variables include percentage of assets held by the top five banks (top5), the average number of branches per bank (bch_bn), three dummy variables for interstate banking activity [the first dummy variable (regid) is one if a state possesses regional reciprocity, zero otherwise; the second (nation) is one if a state possesses national reciprocity, zero otherwise; and the third (non) is one is a state possesses national non-reciprocity, zero otherwise], and the state unemployment rate (unem). The Hausman test chooses between the random-effect model, the null-hypothesis, and the fixed-effect model. The coefficient estimate appears in the first column followed by its t-statistic in the next.

* means significantly different from zero at the 1-percent level.

** means significantly different from zero at the 5-percent level

Appendix A: Ideal Nationwide Dynamic Decomposition

<u>DERIVATION OF PROPOSITION</u>:

We can rewrite the change in return on equity as follows:

$$\begin{aligned}
\Delta R_t &= R_t - R_{t-1} \\
&= \sum_{i=1}^{n_t} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}+n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}+n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \qquad (A1)
\end{aligned}$$

<u>Decomposition 1</u>: [Use period (t-1) as the base period.]

Adding the term $\sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t}$, which equals zero, to the right hand side of (A1) produces the following:

$$\begin{aligned}
\Delta R_t &= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} + [\sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t}] \\
&= [\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t}] + [\sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1}] + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} (r_{i,t} - r_{i,t-1})\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}(\theta_{i,t} - \theta_{i,t-1}) + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1}
\end{aligned}$$

Note that $\sum_{i=1}^{n_t} \theta_{i,t} = 1$ and $\sum_{i=1}^{n_{t-1}} \theta_{i,t-1} = 1$. Thus, we have that

$$\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + \sum_{i=1}^{n_t^{entry}} \theta_{i,t} = 1 \text{ and } \sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} + \sum_{i=1}^{n_{t-1}^{exit}} \theta_{i,t-1} = 1 \qquad (A2)$$

Therefore, we have that

$$
\begin{aligned}
\Delta R_t &= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&\quad - R_t[\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + \sum_{i=1}^{n_t^{entry}} \theta_{i,t}] + R_t[\sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} + \sum_{i=1}^{n_t^{entry}} \theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,\Delta t} - R_t \sum_{i=1}^{n_t^{stay}} \theta_{i,t} + R_t \sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} \\
&\quad + [\sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - R_t \sum_{i=1}^{n_t^{entry}} \theta_{i,t}] - [\sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} - R_t \sum_{i=1}^{n_{t-1}^{exit}} \theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,\Delta t} - \sum_{i=1}^{n_t^{stay}} R_t(\theta_{i,t} - \theta_{i,t-1}) \\
&\quad + [\sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_t)\theta_{i,t}] - [\sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t)\theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,\Delta t} - \sum_{i=1}^{n_t^{stay}} R_t\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_t)\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t)\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_t)\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_t)\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t)\theta_{i,t-1} \qquad (A3)
\end{aligned}
$$

<u>Decomposition 2</u>: [Use period (t) as the base period.]

Adding the term $\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1} - \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1}$, which equals zero, to the right hand side of (A1) produces the following:

$$
\begin{aligned}
\Delta R_t &= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} + [\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1} - \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1}] \\
&= [\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1}] + [\sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t-1} - \sum_{i=1}^{n_t^{stay}} r_{i,t-1}\theta_{i,t-1}] + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}(\theta_{i,t} - \theta_{i,t-1}) + \sum_{i=1}^{n_t^{stay}} (r_{i,t} - r_{i,t-1})\theta_{i,t-1} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} + \sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1}
\end{aligned}
$$

With (A2), we have that

$$
\begin{aligned}
\Delta R_t &= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,t} + \sum_{i=1}^{n_t^{entry}} r_{i,\Delta t}\theta_{i,t-1} - \sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} \\
&\quad - R_{t-1}[\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + \sum_{i=1}^{n_t^{entry}} \theta_{i,t}] + R_{t-1}[\sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} + \sum_{i=1}^{n_{t-1}^{entry}} \theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} - R_{t-1}\sum_{i=1}^{n_t^{stay}} \theta_{i,t} + R_{t-1}\sum_{i=1}^{n_t^{stay}} \theta_{i,t-1} \\
&\quad + [\sum_{i=1}^{n_t^{entry}} r_{i,t}\theta_{i,t} - R_{t-1}\sum_{i=1}^{n_t^{entry}} \theta_{i,t}] - [\sum_{i=1}^{n_{t-1}^{exit}} r_{i,t-1}\theta_{i,t-1} - R_{t-1}\sum_{i=1}^{n_{t-1}^{exit}} \theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} - \sum_{i=1}^{n_t^{stay}} R_{t-1}(\theta_{i,t} - \theta_{i,t-1}) + [\sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_{t-1})\theta_{i,t}] - [\sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_{t-1})\theta_{i,t-1}] \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,t}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} - \sum_{i=1}^{n_t^{stay}} R_{t-1}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_{t-1})\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_{t-1})\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} (r_{i,t} - R_{t-1)}\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_{t-1})\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_{t-1})\theta_{i,t-1} \qquad (A4)
\end{aligned}
$$

<u>Decomposition 3</u> [Determine the ideal dynamic decomposition.]

Add the previous two decompositions together, (A3) plus (A4). Thus,

$$
\begin{aligned}
2\Delta R_t &= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t} + \sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_t)\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_t)\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t)\theta_{i,t-1} \\
&\quad + \sum_{i=1}^{n_t^{stay}} (r_{i,t} - R_{t-1})\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\theta_{i,t-1} + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_{t-1})\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_{t-1})\theta_{i,t-1} \\
&= \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}(\theta_{i,t} + \theta_{i,t-1}) + \sum_{i=1}^{n_t^{stay}} (r_{i,t-1} - R_t + r_{i,t} - R_{t-1})\theta_{i,\Delta t} \\
&\quad + \sum_{i=1}^{n_t^{entry}} (r_{i,t} - R_t + r_{i,t} - R_{t-1})\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} (r_{i,t-1} - R_t + r_{i,t-1} - R_{t-1})\theta_{i,t-1}
\end{aligned}
$$

$$
\Delta R_t = \sum_{i=1}^{n_t^{stay}} r_{i,\Delta t}\overline{\theta_i} + \sum_{i=1}^{n_t^{stay}} \left[\overline{r_i} - \overline{R}\right]\theta_{i,\Delta t} + \sum_{i=1}^{n_t^{entry}} \left[r_{i,t} - \overline{R}\right]\theta_{i,t} - \sum_{i=1}^{n_{t-1}^{exit}} \left[r_{i,t-1} - \overline{R}\right]\theta_{i,t-1} \qquad Q.E.D.
$$

where $\bar{\theta}_i = (\theta_{i,t} + \theta_{i,t-1})/2$,

$\bar{r}_i = (r_{i,t} + r_{i,t-1})/2$, and

$\bar{R} = (R_t + R_{t-1})/2$.

Appendix B: Ideal State-Level Dynamic Decomposition

Since our illustration uses the U.S. commercial banking industry, our derivation of the various dynamic decompositions employs industry return on equity (R). The return on equity at time t (R_t) equals net income (NI_t) at time t divided by equity (E_t) at time t. That is,

$$
\begin{aligned}
R_t &= \frac{NI_t}{E_t} \\
&= \frac{\sum_{s=1}^{S}\sum_{i=1}^{n_s} NI_{i,s,t}}{\sum_{s=1}^{S}\sum_{i=1}^{n_s} E_{i,s,t}} \\
&= \sum_{s=1}^{S}\left[\frac{\sum_{i=1}^{n_s} NI_{i,s,t}}{\sum_{s=1}^{S}\sum_{i=1}^{n_s} E_{i,s,t}}\right] \\
&= \sum_{s=1}^{S}\left[\frac{\sum_{i=1}^{n_s} NI_{i,s,t}}{\sum_{i=1}^{n_s} E_{i,s,t}}\frac{\sum_{i=1}^{n_s} E_{i,s,t}}{\sum_{s=1}^{S}\sum_{i=1}^{n_s} E_{i,s,t}}\right] \\
&= \sum_{s=1}^{S}\left[\sum_{i=1}^{n_s}\left(\frac{NI_{i,s,t}}{E_{i,s,t}}\frac{E_{i,s,t}}{\sum_{i=1}^{n_s} E_{i,s,t}}\right)\frac{\sum_{i=1}^{n_s} E_{i,s,t}}{\sum_{s=1}^{S}\sum_{i=1}^{n_s} E_{i,s,t}}\right] \\
&= \sum_{s=1}^{S}\left[\sum_{i=1}^{n_s}\left(r_{i,s,t}\theta_{i,s,t}\right)\theta_{s,t}\right] \\
&= \sum_{s=1}^{S}\theta_{s,t}\sum_{i=1}^{n_s} r_{i,s,t}\theta_{i,s,t}
\end{aligned}
$$

or

$$R_t = \sum_{s=1}^{S}\theta_{s,t}R_{s,t} \ ,$$

where $R_{s,t} = \sum_{i=1}^{n_s} r_{i,s,t}\theta_{i,s,t}$.

Thus, we can calculate, using period (t-1) as the base period, that

$$
\begin{aligned}
\Delta R_t &= R_t - R_{t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} + R_t - R_t \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} + R_t \sum_{s=1}^{S} \theta_{s,t-1} - R_t \sum_{s=1}^{S} \theta_{s,t} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - R_t \sum_{s=1}^{S} \theta_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t} + R_t \sum_{s=1}^{S} \theta_{s,t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} \left(R_{s,t} - R_t\right) + \sum_{s=1}^{S} \theta_{s,t-1} \left(R_{s,t} - R_{s,t-1}\right) - \sum_{s=1}^{S} \theta_{s,t-1} \left(R_{s,t} - R_t\right) \\
&= \sum_{s=1}^{S} \theta_{s,\Delta t} \left(R_{s,t} - R_t\right) + \sum_{s=1}^{S} \theta_{s,t-1} R_{s,\Delta t}
\end{aligned}
$$

In that derivation, we used the fact that $\sum_{s=1}^{S} \theta_{s,t-1} = \sum_{s=1}^{S} \theta_{s,t} = 1$. Now, we can recalculate, using period t as the base period, as follows:

$$
\begin{aligned}
\Delta R_t &= R_t - R_{t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} - \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} + R_{t-1} - R_{t-1} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} - \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} + R_{t-1} \sum_{s=1}^{S} \theta_{s,t-1} - R_{t-1} \sum_{s=1}^{S} \theta_{s,t} \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,t} - \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} - \sum_{s=1}^{S} \theta_{s,t-1} R_{s,t-1} + R_{t-1} \sum_{s=1}^{S} \theta_{s,t-1} + \sum_{s=1}^{S} \theta_{s,t} R_{s,t-1} - R_{t-1} \sum_{s=1}^{S} \theta_{s,t} \\
&= \sum_{s=1}^{S} \theta_{s,t} \left(R_{s,t} - R_{s,t-1}\right) - \sum_{s=1}^{S} \theta_{s,t-1} \left(R_{s,t-1} - R_{t-1}\right) + \sum_{s=1}^{S} \theta_{s,t} \left(R_{s,t-1} - R_{t-1}\right) \\
&= \sum_{s=1}^{S} \theta_{s,t} \left(R_{s,t} - R_{s,t-1}\right) + \sum_{s=1}^{S} \left(\theta_{s,t} - \theta_{s,t-1}\right)\left(R_{s,t-1} - R_{t-1}\right) \\
&= \sum_{s=1}^{S} \theta_{s,t} R_{s,\Delta t} + \sum_{s=1}^{S} \theta_{s,\Delta t} \left(R_{s,t-1} - R_{t-1}\right)
\end{aligned}
$$

Adding those two results together gives the following relationship:

$$2\Delta R_t = \sum_{s=1}^{S}\left(\theta_{s,t} + \theta_{s,t-1}\right)R_{s,\Delta t} + \sum_{s=1}^{S}\theta_{s,\Delta t}\left[\left(R_{s,t} + R_{s,t-1}\right) - \left(R_t + R_{t-1}\right)\right]$$

$$\Delta R_t = \sum_{s=1}^{S}\left(\frac{\theta_{s,t} + \theta_{s,t-1}}{2}\right)R_{s,\Delta t} + \sum_{s=1}^{S}\theta_{s,\Delta t}\left[\left(\frac{R_{s,t} + R_{s,t-1}}{2}\right) - \left(\frac{R_t + R_{t-1}}{2}\right)\right]$$

$$\Delta R_t = \underbrace{\sum_{s=1}^{S}\bar{\theta}_s R_{s,\Delta t}}_{\text{"within effect"}} + \underbrace{\sum_{s=1}^{S}\theta_{s,\Delta t}\left[\bar{R}_s - \bar{R}\right]}_{\text{"between effect"}}$$

The ideal dynamic decomposition of nationwide effects includes two state effects, the within effect and the between (reallocation) effect. Furthermore, we can decompose each $R_{s,\Delta t}$ as we do for the national data (see Appendix A)

$$R_{s,\Delta t} = \underbrace{\sum_{i=1}^{n_{s,t}^{stay}} r_{i,s,\Delta t}\bar{\theta}_{i,s}}_{\text{“within effect”}} + \underbrace{\sum_{i=1}^{n_{s,t}^{stay}} (\bar{r}_{i,s} - \bar{R}_s)\theta_{i,s,\Delta t}}_{\text{“between effect”}} + \underbrace{\sum_{i=1}^{n_{s,t}^{enter}} (r_{i,s,t} - \bar{R}_s)\theta_{i,s,t}}_{\text{“entry effect”}}$$

$$\underbrace{- \sum_{i=1}^{n_{s,t}^{exit}} (r_{i,s,t-1} - \bar{R}_s)\theta_{i,s,t-1}}_{\text{“exit effect”}} .$$

where $\bar{\theta}_{i,s} = (\theta_{i,s,t} + \theta_{i,s,t-1})/2$,

$\bar{r}_{i,s} = (r_{i,s,t} + r_{i,s,t-1})/2$, and

$\bar{R}_s = (R_{s,t} + R_{s,t-1})/2$.