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The Nature of Aggregate and Regional Canada-US Trade (1990-2011)

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About the Border Policy Research Institute

The BPRI focuses on research that informs policy-makers on matters related to the Canada-U.S. border. Policy areas of importance include transportation and mobility, security, immigration, energy, environment, economics and trade.

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Executive Summary

The impact of post-9/11 border security developments on Canada-U.S. trade has been the focus of much attention in recent years. The available evidence suggests that both U.S. exports and imports with Canada grew more slowly after 9/11 than would otherwise have been the case.

Intra-industry trade (IIT) has been an important feature of bilateral trade. One reason for academic and policy interest in IIT is its linkage to product specialization and the presence of industrial clusters. In particular, IIT will reflect, in part, cross-border shipments of goods by multinational companies operating regional supply chains characterized by specialized production and distribution facilities that are located in relatively close proximity on each side of the border. Hence, IIT is a reflection of the existence and growth of regional trade corridors and clusters.

Available evidence indicates that IIT's share of total bilateral trade increased throughout the decade of the 1970's and 1980's. However, the relative importance of IIT in 2011 was about the same as it was in 1990, notwithstanding the implementation of the Canada-U.S. Free Trade Agreement in 1989 and the growth of real incomes in both countries, along with increased overall trade.

The purpose of this study is to examine in detail the behavior of bilateral IIT in the post-1990 period. A particular focus is to assess whether post-9/11 border security developments may have discouraged the continued growth of IIT relative to total bilateral trade.

The primary contribution of the study is a statistical analysis of IIT undertaken for total bilateral trade, as well as for 8 northern U.S. customs districts that account for the bulk of U.S. trade with Canada. The analysis sought to identify whether a continuation of the pre-2001 time series patterns for IIT would have resulted in higher IIT values than were forecast from a model of IIT estimated over the full period 1990-2011. In undertaking the analysis, the anticipated adverse impact on IIT of the recent recession was also taken into account.

Our results suggest that post-9/11 border developments may well have contributed to lower overall values of IIT than would have been expected from an extrapolation of pre-9/11 time series patterns; however, holding the impact of the recession on IIT constant, we cannot identify a statistically significant impact of post-9/11 border developments, per se. On the other hand, this statistically insignificant overall result masks different experiences across the individual customs districts.

In brief, the IIT experiences of individual customs districts differ substantially. For example, whereas IIT for the Detroit district actually seems to increase, at least initially, in the post-2001 period, IIT seems to suffer post-2001 in most other customs districts. This is particularly true for Buffalo where IIT, especially for finished goods, falls well below its extrapolated post-2001 values. The atypical result for the Detroit customs district arguably reflects the superior ability of vertically integrated, large transportation equipment manufacturers to benefit from government programs such as FAST which were implemented to mitigate commercial border crossing delays in the context of higher border security.

Given the large relative size of the Detroit customs district in total bilateral trade, and the atypical IIT time series pattern for that district, it seems clear that overall bilateral IIT would have decreased significantly in the post-2001 period were it not for the adjustments that the large auto companies were able to make to border thickening following the terrorist attacks of 9/11.

Our analysis also highlights differences across customs districts in the impacts of border thickening on IIT for intermediate versus final goods. Specifically, for several districts, most notably Buffalo,

the major impact of post-9/11 border thickening was on IIT in final goods. For other districts, the major impact was on IIT in intermediate goods.

Therefore, an important conclusion of our study is that changes in aggregate patterns of bilateral trade may obscure prominent differences in patterns for individual regional trade corridors. Indeed, in the case of IIT, there are marked differences in the post-2001 experiences of the two largest northern U.S. customs districts, i.e. Detroit and Buffalo.

1.0 Introduction

The impact of post-9/11 border security developments on Canada-U.S. trade has been the focus of substantial attention on the part of government policy makers, academics and private sector managers. Particular concern has been expressed about those developments contributing to a "thickening" of the border and, hence, to an adverse impact on the volume of bilateral trade. Relatively recent evidence provides support for this concern. Specifically, it suggests that both U.S. exports and imports with Canada grew more slowly after 9/11 than would otherwise have been the case.[1]

Specific features of Canada-U.S. trade have also received significant attention from researchers and policymakers. In particular, the extent to which trade occurs between industries (inter-industry trade) as opposed to within industries (intra-industry trade) has been of interest (Balassa, 1986a; Globerman and Dean, 1990; and Head and Ries, 2001). One reason for the attention to the mix between inter and intra-industry trade (henceforth IIT) is that IIT entails smaller factor market adjustments than inter-industry trade (Balassa, 1986b). Specifically, the costs of retraining and relocating workers are likely to be lower when workers move to new jobs characterized by production and marketing conditions similar to their old jobs than when the new jobs require significantly different skills than the old jobs.

The prominence of IIT in total trade is also of interest because of its linkage to product specialization and the presence of industrial clusters. For example, Kristjansson, Bomba and Goodchild (2010) assert that a higher degree of product specialization in trade suggests that the underlying production and distribution activities of the trading partners are more tightly integrated. In particular, IIT will reflect, in part, cross-border shipments of intermediate goods by multinational companies (MNCs) that are operating regional or global supply chains. The need for timely delivery of intermediate inputs, in turn, suggests that specialized production and distribution facilities will be located in relatively close proximity on each side of the Canada-U.S. border.[2] Similarly, Brown (1998) notes that interregional trade appears to be highest among regions that are in close physical proximity and with similar industrial structures, while Wolf, Dunemann and Egelhoff (2012) emphasize the strong linkage between low geographic distance and effective knowledge transfer across firms. Knowledge transfer, in turn, is an important phenomenon underlying geographic industrial clusters.

In short, the growth of IIT as a share of total bilateral trade suggests a growing cross-border similarity in production and distribution activities, as well as in scientific and technical knowledge and expertise, which, in turn, underlies cross-border industrial clusters. In particular, locational proximity of specialized producers and distributors contributes to external economies of scale which, in turn, promote the growth of local or regional clusters of firms in similar or related industries. Hence, the share of IIT in total bilateral trade might be a more economically meaningful indicator of the degree of integrated production between Canada and the United States than is overall bilateral trade.[3]

[1] See Globerman and Storer (2008; 2009).

[2] There is substantial evidence that IIT is negatively associated with the physical distance between trading partners. See, for example, Brulhart (2009). Rice, Stewart and Venables (2002) argue that this phenomenon reflects the fact that geographic proximity is coincident with similar supply and demand structures.

[3] Blank (2010) asserts that Canada-U.S. trade growth in the period following the Canada-U.S. Free Trade Agreement is more about the two countries "making things together," than selling goods to each other. He also highlights the growth of specialized regional trade corridors. Bergman and Feser (1997) and Roelandt and der Hertag (1999) document how clusters in Europe are based, in part, on trade linkages.

Several studies document the empirical importance of IIT as a share of bilateral trade.[4] Moreover, available evidence indicates that IIT's share of total bilateral trade increased throughout the decades of the 1970s and 1980s (Globerman and Dean, 1990; Globerman, 1992); however, as will be discussed in a later section of this report, IIT's share of overall Canada - U.S. bilateral trade was basically the same in 2011 as it was in 1990, notwithstanding the implementation of prominent trade agreements that might have been expected to encourage the growth of IIT as a share of total trade.[5] Indeed, the available literature suggests that trade liberalization agreements typically encourage IIT relative to inter-industry trade.[6]

The primary purpose of this study is to examine in detail the behavior of bilateral IIT in the post-1990 period from the perspective of U.S. trade flows with Canada. That is, U.S. trade data are used rather than Canadian data. A particular focus is to assess whether post-9/11 border security developments may have discouraged the continued growth of IIT relative to total bilateral trade. A related focus is to identify whether patterns of IIT growth in the post-1990 period are similar across different Canada-U.S. regional trade corridors. Several studies highlight regional differences in Canada-U.S. trade patterns, including the degree of product specialization (Beine and Coulombe, 2004; Vogiatzoglou (2006a); however, very few studies identify and compare regional IIT behavior over time.[7] Analysis of IIT behavior at the regional level could provide some insight into whether and how border security developments have differentially influenced cluster developments in different geographic regions of North America.

The study proceeds as follows. Section 2 discusses two alternative measures of IIT. It also reports evidence for those two measures for both total Canada-U.S. trade over the period 1990-2011, as well as for trade within major regional trade corridors over the same period. Section 3 discusses the basic determinants of inter and intra-industry trade with particular attention to the likely impact of border thickening on each form of trade. Econometric evidence on the impact of post-9/11 border thickening on IIT is presented and discussed in Section 4, both for aggregate bilateral trade, as well as for regional trade. Section 5 evaluates whether the impact of border thickening in the post-2001 period affected IIT in intermediate goods differently than trade in final goods. Finally, Section 6 contains a summary and conclusions.

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[4] Melitz and Trefler (2012) note that Canada and the U.S. represent the world's largest example of bilateral intra-industry trade.

[5] The Canada-U.S. Free Trade Agreement (CUSTA) was implemented in 1989, while the North American Free Trade Agreement (NAFTA) was implemented in 1994.

[6] See Sharma (1999).

[7] For one study that does so on limited geographic basis, see Kristjansson, Bomba and Goodchild (2010).

2.0 Overview of Bilateral IIT

In this section, we present descriptive information on IIT's share of total and regional bilateral trade from 1990-2011. Both average and marginal IIT (MIIT) ratios are reported based upon U.S. exports and imports with Canada. Before presenting and discussing these ratios, we review the methodology for estimating IIT and MIIT ratios.

2.1 The Grubel-Lloyd Index

The standard measure of IIT for any good G_i is the Grubel-Lloyd Index (GLI) which is defined as:

$$GLI_i = 1 - Abs\ [(X_i - M_i)/(X_i + M_i)]$$

where X_i denotes exports of the i^{th} good and M_i denotes imports of that good. The term Abs denotes absolute value. The GLI will equal unity if exports equal imports, since the absolute value expression will equal zero. At the other extreme, if trade is "one-way", i.e. either exports or imports of a good are zero-valued, the GLI will equal zero, since the absolute value expression will equal unity.[8] GLI essentially expresses what fraction of total bilateral trade in a good consists of balanced two-way trade.

Since the GLI is typically analyzed at the industry level, rather than at the level of individual goods, the GLI values calculated for the individual goods comprising any industrial category must be "averaged." Typically, the average GLI for an industry is estimated using the trade weights of the individual goods in the industrial category. The trade weight of any good is calculated as the value of exports plus imports for that good divided by the sum of exports plus imports for all goods comprising the relevant industrial category. As a simple illustration, imagine that an industry consists of three goods, where each good accounts for exactly one-third of total industry exports plus imports. The GLI for the industry would be calculated by multiplying the GLI values for each good by .333 and summing the resulting product terms. As is the case for individual goods, the industry GLI value will also be bounded by zero and unity.[9]

The issue of how broadly or narrowly to define industries for purposes of calculating their GLIs is somewhat contentious. The more highly aggregated the industrial classification, the higher will be the calculated GLI, all other things constant. Conversely, the more narrowly an industry is defined in terms of its constituent products, the lower will be the GLI.[10]

In fact, there is no universally accepted level of industrial aggregation for purposes of calculating GLI values. Most researchers have simply adopted the convention of choosing a "mid-range" level of aggregation, e.g. the 4-digit or 6-digit level of the industry classification system utilized. In this study, we first estimate GLIs for different levels of industry aggregation and assess whether the general findings are sensitive to the specific level of aggregation. In fact, the time series pattern of IIT over our sample period is relatively insensitive to the specific level of industrial aggregation selected.

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[8] See Grubel and Lloyd (1975) for a full discussion of the measurement of IIT. In principle, it should not matter whether U.S. or Canadian trade data are used to calculate IIT. In practice, differences in data collection procedures between the two countries might contribute to small differences depending upon which country's data are used.

[9] In fact, we calculate the GLI values at the level of the industry and then create weighted average GLI values for all industries in each customs district and for all districts combined.

[10] This phenomenon is called the "categorical aggregation problem." See Oliveras and Terra (1997) for an extensive discussion of the aggregation issue.

2.2 Marginal IIT

The GLI measure of intra-industry trade has been criticized on the grounds that a change in the calculated index between any two time periods might misrepresent the growth of actual two-way trade in any given set of products (Hamilton and Kniest, 1991; Brulhart and Thorpe, 2001). This concern can be illustrated by the following hypothetical example. Imagine that trade between Canada and the U.S. is limited to two goods (A and B). In year one, the U.S. exports 10 units of A to Canada and imports 10 units of B. It imports no units of A from Canada, nor does it export any units of B to Canada. In year two, the U.S. continues to export 10 units of A to Canada but imports 10 units of A from Canada. It continues to import 10 units of B from Canada but also exports 10 units of B to Canada. In effect, the difference between the two years involves the U.S. commencing imports of A from Canada while commencing exports of B to Canada. Under these assumed conditions, the calculated GLI for bilateral trade would increase from zero to 1. However, the increase in trade in each good was effectively one-way, i.e. imports of A from Canada and exports of B to Canada. The GLI increases in this example because there is more balanced trade in each good given that the U.S starts out with unbalanced trade in each good.

To the extent that one cares about why U.S. trade with Canada becomes more balanced (in a two-way direction) across a set of goods, one might want to calculate the marginal intra-industry trade index (MIIT). The MIIT of a good is calculated as follows:

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MIIT = 1 – Abs(dX-dM)/((Abs(dX) + Abs(dM))
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where dX is the change in exports of a good, dM is the change in imports of that good and Abs indicates the absolute value of the change in X or M. The MIIT for any industry would be calculated as the weighted average of the MIIT for the individual goods comprising the industry, where the weights would be the change in exports plus imports for each good as a share of the total change in exports plus imports for all goods comprising the industry.[11] By definition, the MIIT index is zero if exports and imports change in the opposite direction and between zero and one if they change in the same direction.

In the preceding hypothetical example, the U.S. increases its imports of A by 10 units but does not increase its exports of A. As a consequence, the calculated MIIT for Good A would equal zero. At the same time, the U.S. increases its exports of B by 10 units but does not increase imports of B. So the calculated MIIT for Good B would also equal zero. Obviously, the weighted average MIIT for the two goods is zero. The point here is that the calculated MIIT shows that the observed balanced trade in both goods in the second time period is the result of increased one way trade (in opposite directions) for each good, as opposed to an increase in two-way trade. To the extent that two-way balanced trade in individual goods is associated with greater economies of specialization and agglomeration economies (i.e. clustering), one might not particularly care how it is achieved. Thus, in the preceding example, one might not care if the two-way trade in both goods (A and B) was balanced from the start or became balanced over time. On the other hand, if incremental trade is two-way for individual goods, it might connote smoother economic adjustments to trade growth, as compared to increased trade that reduces trade imbalances across individual goods comprising an industry.

[11] For a discussion of how to measure MIIT, see Oliveras and Terra (1997).

2.3 IIT Values for Total Bilateral Trade

Table 1 reports GLI values for total U.S. merchandise trade with Canada for 4, 6, 8 and 10-digit HTS industry classifications averaged over four different time periods spanning the years 1990-2011.[12] What seems particularly notable about the data reported in Table 1 is that the GLI values at the end of the sample time period are actually slightly lower than at the beginning of the period, with the exception of the 10-digit level of aggregation. This pattern is clearly different from the fairly consistent increase in bilateral IIT over the 1970s and 1980s discussed earlier.

It is also notable that the GLI values increased from 1990-2000 but then commenced declining beginning in 2001. This pattern is suggestive of an adverse impact of post-9/11 border security developments on IIT; however, it is also possible that the decreases in GLI values from 2006 to 2011 partly reflect the severe U.S. recession commencing in 2008 and the slow economic recovery characterizing the subsequent years. By way of illustration, GLI values in 2007 at the 4 and 6-digit HST levels are .524 and .457, respectively. The corresponding values in 2010 are .458 and .406. Since IIT is a positive function of total trade (Brulhart, 2009), the approximately 24 percent decline in total bilateral trade between 2007 and 2009 (see Table 11) might explain some of the observed decrease in IIT between 2005 and 2011.

Table 2 reports our calculated GLI values for each year from 1990-2011 at the 6-digit HTS level for overall Canada-U.S. bilateral trade.[13] The overall impression is of relatively little change in IIT over much of the sample time period with a notable, but modest decline from 2007-2010. These Canada-U.S. results can be compared with longer-term world-wide trends in IIT as examined by Melitz and Trefler (2012). The authors use data from Brulhart (2009) to examine the share of total trade that is within industries. Their graphical analysis shows a generally increasing trend from 1962 through the mid-1990s with a discernible flattening of the trend after 1998. They also observe a large drop in the share of IIT in the mid-1970s, likely as a result of the first OPEC oil shock and the fact that they do not exclude energy products from their analysis. Melitz and Trefler base their analysis on SITC data for two different aggregation levels but find similar trends over time, although the precise values of the series differ, as expected, between the two levels of aggregation. The recent flattening of the trend of the share of IIT in total trade identified by Melitz and Trefler is similar to the time series behavior of bilateral IIT post-1990 identified in Tables 1 and 2.

In a later section of the report, we will discuss some econometric evidence relevant to explaining the observed changes in annual GLI values reported in Table 2. At this point, we compare the findings reported in Tables 1 and 2 to evidence on Canada-U.S. bilateral IIT presented in other studies. In one such study, Brulhart and Thorpe (2001) discuss IIT for the years 1980, 1990, 1995 and 1998. They calculate GLI values at the 3-digit SITC levels for those years. For all goods, as well as for manufacturing industries exclusively, IIT increases over the sample period; however, the increase for manufacturing over the full period is relatively small. Specifically, the estimated GLI for manufacturing was .66 in 1980, .68 in 1990 and .72 in 1998. For all goods, the GLI was .56 in 1980, .62 in 1990 and .67 in 1998. Hence, at the 3-digit SITC level, Brulhart and Thorpe identify a very modest increase in bilateral IIT for all goods over the period 1990-1998, with the calculated GLI increasing from .62 to .67. By comparison, our GLI estimates at the six-digit level also show a modest, albeit smaller, increase over the period 1990-1998, i.e. from 0.45 to 0.47.

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[12] By averaging over several years, we minimize the influence of relatively random year-to-year changes. The HTS classification stands for the Harmonized Tariff Schedule. Hence, it is a tariff-based system for classifying goods to specific industries.

[13] Given very high correlations between GLI values across different HTS industry aggregation levels, for convenience we report annual results only for the HTS 6-digit level.

Ekanayake, Veeramacheneni and Moslares (2009) estimate the shares of IIT in U.S. total trade at the 10-digit HST for the years 1990-2007. The trade data include both manufactured and non-manufactured products. The calculated GLI for U.S. trade with Canada was 0.329 in 1990 and 0.364 in 2001, after which it declined to 0.357 in 2007.[14]

Vogiatzoglu (2006b) reports GLI values for total bilateral manufacturing at the 3-digit SITC level for the period 1992-2002, where U.S. trade flows with Canada are broken down into horizontal and vertical trade. The former represents trade in goods of equal monetary value, whereas the latter represent trade in goods of different monetary value. The distinction is meant to identify IIT in goods of equal versus different quality. Vogiatzoglu finds that bilateral horizontal IIT for total manufacturing increased over the sample period, while vertical IIT decreased. The overall net result is a modest increase in overall bilateral IIT. This result is consistent with the GLI values for total bilateral trade that we report in Table 2. Specifically, our estimates also show a small increase in IIT over the period 1992-2002.

Finally, Montout, Mucchielli and Zignago (2002) analyze intra and inter-industry trade for the automobile industry covering the period 1992-1999. The calculated GLI was around 0.50 in the early 1990s and remained stable for the rest of their sample period. Bilateral IIT in automobiles was primarily horizontal with the latter accounting for more than 55% of total bilateral trade in automobiles over the sample period. Since trade in automotive products is an important component of total bilateral trade, the finding of a relatively stable IIT share for automotive products is consistent with the relative stability of overall bilateral IIT identified above.

2.4 IIT Values at the District Level

In this section, we report GLI values for eight U.S. customs districts that account for most bilateral trade. The sample customs districts identified in Table 3 are those containing land ports at the Canada-U.S. border.[15] The customs districts differ in terms of the number of land border ports they contain, as well as in the volume of trade that they process. As shown in Table 3, Detroit is by far the largest customs district, accounting for more than one-third of bilateral trade over the sample period. Other than Buffalo, the remaining customs districts account for relatively small shares of bilateral trade.[16]

The calculated GLIs at the 6-digit HTS level for the various customs districts, as well as for total bilateral trade, are reported in Table 4.[17] One observation is that GLI values for Buffalo and Detroit are typically substantially higher than for other customs districts, with the exception of St. Albans and Ogdensburg at the beginning of the sample. Indeed, GLI values for several districts including Great Falls, Pembina, Portland and Seattle are low, both relatively and absolutely. Furthermore, they exhibit no secular trend towards growth over the sample period. These results suggest that substantial cross-border industrial clusters are primarily concentrated in the two largest regional trade corridors, i.e. Detroit and Buffalo. Ogdensburg, encompassing the trade corridor from Eastern Ontario to New York State appears to be the third largest industrial cluster. While the majority of bilateral trade throughout our sample time period is inter-industry trade, IIT is a particularly small

[14] It is interesting to note that the calculated GLI for U.S. trade with Mexico was virtually unchanged between 1990 (0.297) and 2001 (.291). However, it increased slightly to 0.311 in 2007.

[15] One customs district (Duluth) was dropped from the sample because the composition of ports for that district changed over the sample time period.

[16] The fraction of total bilateral trade reported in Table 3 is less than unity because of the deleted Duluth district and because some bilateral trade enters the U.S. at customs districts not located at the border.

[17] Graphs of the GLI values over time for the districts are provided in Appendix One.

share of total trade in the majority of customs districts. Hence, notwithstanding substantial trade liberalization and the growth of bilateral trade, cross-border industrial clustering is still a relatively limited geographical phenomenon in the Canada-U.S. context.

A second observation is that the estimated GLI values for individual customs districts vary somewhat over the sample time period. Indeed, there seems to be greater variation of GLI values for individual customs districts than for the overall bilateral GLI.[18] This pattern suggests that there are offsetting changes in IIT over time across customs districts, which is apparent from the data reported in Table 4. In particular, there is a dramatic decline in IIT for St. Albans comparing 1990 to 2001, while there is a substantial increase for Buffalo from 1990-2000.

Table 5 reports the simple correlation coefficients between pairwise GLI values for the sample customs districts at the 6-digit HTS industry level. The correlation coefficients confirm that the behavior of IIT over the sample time period varies fairly considerably across the customs districts. Specifically, the IIT experiences of individual districts tend to be unrelated to the experiences of other districts in many cases. For example, the GLI series for Seattle is negatively correlated with the series for four other districts, although the correlation coefficients are quite low. In the case of Detroit, the GLI series is negatively correlated with six other districts, but in most cases the correlation coefficients are also relatively low. However, in several cases, negative correlation coefficients are relatively high. For example, the correlation between Pembina and Ogdensburg is -0.70, while the correlation between Pembina and St. Albans is -0.77. In several other cases, positive and relatively high correlation coefficients are identified, most notably for the pairwise comparisons of Buffalo with Great Falls, St. Albans with Ogdensburg and Pembina with Portland, respectively.

In summary, the importance of IIT in total trade varies substantially across individual bilateral trade corridors. Unsurprisingly, since IIT is partially a function of the total volume of trade, IIT is particularly prominent for the two largest customs districts: Detroit and Buffalo. Furthermore, the behavior of IIT over the sample time period differs across individual trade corridors. One notable difference is the pattern for Detroit, where the GLI values are significantly higher, on average, in the post-2001 period than in the pre-2001 period. For other customs districts, with the exception of Pembina, average GLI values in the post-2001 period are essentially unchanged, or lower than in the pre-2001 period (see Table 6).

2.5 MIIT Values

The top part of Table 7 reports calculated MIIT values for total incremental bilateral trade, as well as for incremental trade in each individual customs district over the period 1991 through 2011. The bottom part reports mean MIIT values, as well as standard deviations of the MIIT values. Each calculated MIIT value, like the IIT, is bounded between zero and one. An MIIT value closer to unity indicates that incremental trade flows (as distinct from the average of all preceding trade flows) have the same sign and similar absolute values for the individual goods comprising the aggregate industry definition.

When we compare total bilateral and regional IIT as reported in Table 4 to total bilateral and regional MIIT as reported in Table 7, there is more year to year variation in the MIIT measure than in the IIT measure.[19] This is unsurprising, since random factors are more likely to cause changes in trade patterns at the margin; however, the variation in bilateral MIIT across the sample time period is still relatively small. To illustrate, the mean value of MIIT for all bilateral trade over the sample

[18] Notable exceptions to this statement are the Great Falls, Portland and Seattle districts.
[19] Buffalo is a notable exception.

period is 0.27, while the standard deviation is only .05. MIIT values are also relatively stable for individual customs districts (with the exception of St. Albans). Specifically, the mean MIIT values are substantially larger than the corresponding standard deviations.[20] Nevertheless, while no consistent trend can be identified in the behavior of MIIT for overall bilateral trade or for most individual customs districts, there are modest differences across customs districts. This latter observation is illustrated by the correlation matrix for year-to-year MIIT values reported in Table 8. The majority of the correlation coefficients reported in Table 8 are relatively low, although they tend to be positive suggesting a weak propensity for MIIT values to move together over time across customs districts.

It is interesting to consider whether the picture of IIT behavior summarized in Table 4 is comparable to the behavior of MIIT summarized in Table 7. To address this point, we estimate the correlation coefficients between the calculated IIT and MIIT values for all bilateral trade, as well as for each of the 8 customs districts identified in Tables 4 and 7. The results are reported in Table 9. Clearly, there is no significant correlation between the two trade measures for total bilateral trade. This might be explained by the fact that the MIIT changes for total bilateral trade are relatively small and random events. Conversely, for most of the individual customs districts, the correlation coefficients between IIT and MIIT are positive and statistically significant. Nevertheless, since most studies focus on IIT rather than MIIT, our econometric analysis of intra-industry trade behavior will focus on changes over time in average rather than marginal GLI values.

By way of comparison, Brulhart and Thorpe (2001) also provide estimates of MIIT for U.S. trade with Canada, although at the three digit SITC level. Specifically, they calculate the average MIIT coefficient for all goods and for manufactured goods separately for the time periods 1980-85, 1985-90, 1990-95 and 1995-98. Broadly consistent with the findings we report in Table 7, their calculated MIIT values are little changed when comparing 1990-95 to 1995-98, although there was apparently a fairly substantial increase in calculated MIIT values when comparing 1985-90 to 1990-95.

2.6 Overall Summary of IIT Patterns

Several inferences might be drawn from the data presented to this point. One is that overall bilateral IIT failed to increase consistently over the period 1990-2011 after having increased fairly consistently throughout the 1970s and 1980s. This also appears to be true for most individual customs districts. Specifically, the beginning and end-year GLI values are quite comparable for individual customs districts with the exception of St. Albans and Buffalo. However, customs districts differ with respect to year-to-year changes in GLI values over the sample time period. For example, Buffalo is characterized by a noticeable increase in IIT between 1990 and 2000, as is Pembina, whereas St. Albans exhibits a substantial decrease. A second inference is that there are persistent and substantial differences in IIT across customs districts. Indeed, relatively little bilateral trade passing through the majority of customs districts can be characterized as IIT in nature. In short, IIT behavior for aggregate bilateral trade can obscure differences in IIT behavior across individual trade corridors. Differences across trade corridors, in turn, might reflect differences in the industrial composition of trade, as well as different geographic impacts of events such as border security developments.

In the remainder of this report, we assess the behavior of bilateral and regional IIT in more detail. Particular attention is paid to whether post-9/11 border security developments may have influenced

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[20] The ratio of the mean MIIT to its standard deviation ranges from a high of around 6 for Ogdensburg and Seattle to 1.3 for St. Albans.

the observed behavior of IIT over the sample period. We also discuss possible explanations for differences in IIT behavior across customs districts. Before doing so, we discuss some conceptual determinants of the share of IIT in total trade.

3.0 Determinants of IIT

Total bilateral trade is comprised of trade within industries (IIT) and trade between industries (inter-industry trade). The latter is generally seen to be a function of differences in comparative advantage which, in turn, are largely a function of differences in factor endowments or differences in relative productivity. Thus, differences in relative factor costs and relative productivity are seen as the driving determinants of inter-industry trade.

While differences in the relative prices of factor inputs and productivity can also motivate IIT, the primary features of IIT are the demand for variety combined with economies of scale at the product level. Consumers and firms are willing to pay a premium for more desirable final products and production inputs. By specializing in a narrow range of products within a given industry, producers can better exploit economies of scale and, thereby, lower unit costs and the prices they need to charge to cover their costs (Van Biesebroeck, 2011). Lower unit costs combined with differentiated product features enable producers to sell successfully in export markets which, in turn, enhances economies of scale. The differentiated nature of the products traded accounts for why "similar" products are both exported and imported by a country.[21]

Within this context, IIT will become more prominent relative to inter-industry trade to the extent that the demand for differentiated goods increases and to the extent that product economies of scale become more pronounced relative to differences in relative factor prices. This perspective helps explain why IIT tends to characterize trade among developed countries. Specifically, as real incomes grow, consumers' taste for variety increases. Furthermore, technological innovation is characteristic of developed economies, and such innovation contributes to differences in the productivity of differentiated intermediate inputs used by businesses. Finally, developed countries tend to be more similar to each other than to developing countries in terms of relative factor prices.

Hence, all other things constant, one would expect IIT to increase as a share of total trade as the real incomes of trading partner countries increase. Lower costs of trading goods across borders should also increase IIT's share of total trade. Higher costs of shipping goods across borders oblige all exporters to raise prices in the long run, which should discourage trade, other things held constant; however, it is likely that trade in modestly differentiated products will be especially adversely affected by higher shipping costs that are passed through in the form of higher prices to foreign consumers. This is because the price elasticity of demand for any product will be higher when there are relatively close substitutes available for that product. Exports that are based primarily on their differentiated attributes from products produced by domestic producers in the importing country are therefore likely to be characterized by relatively high price elasticities of demand, if price changes are large relative to the benefits of product differentiation.[22]

Empirical studies of IIT tend to confirm that the prominence of IIT in total trade is positively related to real income levels of the trading partners and negatively related to differences in those real income levels (Andersen, 2003). They also confirm that reductions in barriers to trade tend to

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[21] Differentiation with respect to quality is a feature of IIT models that distinguish between horizontal and vertical IIT.

[22] Fergusson (2008) argues that the elimination of tariffs and the reduction of non-tariff barriers to trade have contributed to the process of specialization, as producers in both Canada and the U.S. are able to produce goods for a larger continent-wide market.

encourage IIT relative to inter-industry trade; however, exchange rate changes and technological changes affecting economies of scale and other characteristics of the production process can also influence the share of IIT in total trade.

With regard to technological change, a number of recent contributions to the literature argue that developed economies have entered an era of "hyper-specialization" whereby substantial productivity gains are being realized from an ever-more specialized division of production tasks (Baldwin, 2011; Malone, Laubacher and Johns, 2011). The increased productivity gains from greater specialization of production reflect, among other things, innovations in information communication technology that facilitate the management of increasingly fragmented value chains across borders. Such developments can be expected to promote increased IIT as a share of total trade. On the other hand, as Melitz and Trefler (2012) note, production specialization in North America began in earnest after the implementation of the Canada-U.S. Autopact in 1965. Hence, the major productivity gains from cross-border specialization of production may have been largely realized, in the Canada-U.S. context, at least for the major traded-goods sector (transportation equipment) in the two or three decades following the implementation of the Autopact.

Working against the growth of IIT in the bilateral context is a "thickening" of the border, particularly since the 9/11 terrorist attacks. This thickening reflects both security initiatives that have increased the cost of shipping goods across the border, as well as differences in regulation between Canada and the United States which effectively act as non-tariff barriers to trade (Robertson, 2011). A thickening of the Canada-U.S. border in the post-9/11 period might well explain why overall IIT as a share of total bilateral trade failed to increase over the full time period of our study. In the next section we consider this issue using econometric analysis.

4.0 Time Series Analysis of IIT

While the GLI values for overall bilateral trade suggest that there was relatively little change in IIT intensity when comparing the beginning and the end of the sample time period, statistical analysis could provide additional support for this conclusion, as well as suggest whether this stability of overall IIT reflects offsetting time-series changes for individual customs districts. In this regard, the plots of GLI values provided in Appendix 1 suggest that for at least some customs districts, IIT intensities increased prior to 2001 but then declined. This pattern might help explain why IIT values at the end of our sample period are typically lower or not much different than the values at the beginning of the sample period.

In this section, we report the results of specifying and estimating a time-series model for the GLI values reported in Table 4. This allows for a more rigorous analysis of IIT changes over time for aggregate trade, as well as trade passing through individual customs districts. Specifically, we specify and estimate a linear time-series model for the period 1990-2011. We allow for both the constant and the slope coefficients to change in 2002, thereby implicitly testing for whether post-9/11 border security developments had a statistical impact on IIT intensity.

4.1 The Model and Estimation Results

The basic linear time series model is specified as Equation 1:

$$\ln GLI_i = C_0 + C_1T_i + C_2d_i + C_3d_iT_i$$

The dependent variable is the natural log value of the calculated GLI for year i. The first independent variable (T_i) is a linear time trend taking an initial value of unity in 1990 and then increasing by one unit for each year after 1990. The variable d is a dummy variable taking a value of zero from 1990-2001 and a value of unity from 2002-2011. The inclusion of d as a separate independent variable allows for the constant term (C_0) to change after 2001. Specifically, C_0 represents the constant term from 1990-2001, while $C_0 + C_2$ represents the constant term from 2002-2011. In principle, the inclusion of d_i allows us to identify whether post-9/11 border security developments exerted any constant impact on IIT values commencing in 2002. Likewise, the inclusion of the interactive term d_iT_i allows us to identify whether there was any change in the trend of IIT commencing in the post-2001 period. Specifically, C_1 is an estimate of the trend in IIT prior to 2002, while $C_1 + C_3$ represents the trend post-2001.

In short, by estimating C_2 and C_3 and then testing for whether the estimated coefficients are statistically significant in terms of their contribution to the explanatory power of the time series model, we gain some insight into whether the behavior of overall bilateral IIT, as well as IIT for individual customs districts, changed in the post-2001 period. Identification of such changes would be consistent with the hypothesis that post-9/11 border-security developments had statistically significant impacts on the share of IIT in bilateral trade.

Before reporting the results of estimating Equation 1 through ordinary least squares, two limitations of our procedure should be explicitly mentioned. First, as noted earlier, the GLI value is bounded between zero and unity. When the dependent variable is bounded, ordinary least squares estimation will produce biased and inconsistent coefficient estimates. While converting GLI values to natural log values mitigates this problem, the estimated regression coefficients may still be biased; however, the estimated coefficients have the advantage of being readily interpreted.

More precise estimation of the time series behavior of GLI can be obtained by following Brulhart (2009) and specifying the dependent variable of Equation 1 as ln (GLI/(1-GLI)). To assess the reliability of our estimation results when the dependent variable is specified as ln (GLI), we also estimate Brulhart's logarithmic transformation of Equation 1 to compare the results to those obtained using ln (GLI) as the dependent variable. The estimation results using Brulhart's logarithmic transformation are reported in Appendix 2. The main finding is that the statistical conclusions are largely unaffected by the precise specification of the dependent variable. Specifically, the signs and significance levels of the coefficients estimated using Brulhart's specification are quite similar to those estimated using ln (GLI) as the dependent variable. Hence, we discuss results below solely for the natural log specification of GLI as the dependent variable.

A second limitation of our simple time series analysis is that Equation 1 does not include structural variables that may influence the behavior of IIT. Hence, there is a possibility that changes ascribed to the time series dummy variables are not the result of post-9/11 border security developments, but rather of other factors exhibiting comparable timing. Of greatest concern in this regard is the major recession commencing in 2008 which could be expected to discourage bilateral trade in the last few years of our time series. It might be argued that trade in specialized intermediate goods is more sensitive to the business cycle than is total trade given the volatility of inventory investments by businesses.[23] Hence, one might expect the behavior of IIT to be particularly sensitive to economic conditions, since trade in specialized intermediate goods is an important component of IIT. In fact, as will be reported below, our conclusions with respect to the post-2001 behavior of IIT are not obviated by explicitly acknowledging the potential influence of the 2008-2009 decrease in total bilateral trade.

Table 10 reports the results of estimating Equation 1 over the period 1990-2011. Statistical results are shown for all districts combined, as well as for the individual customs districts. At the all-district level, the C_2 coefficient is positive and statistically significant, while the C_3 coefficient is negative and statistically significant. The two coefficients are jointly but marginally statistically significant as identified by an F-test. The overall impact of those divergent results for IIT at the aggregate level is discussed below.

The estimated results for the individual districts are broadly consistent with those for overall bilateral IIT. In particular, the results for the largest customs district (Detroit) are quite comparable to the results for the total of all customs districts. Specifically, the C_2 coefficient is positive and statistically significant, the C_3 coefficient is negative and statistically significant and the F-test shows that the coefficients are jointly significant at the .001 level. While the overall trend post-2001 (i.e., $C_1 + C_3$) is negative and larger in absolute value than the trend through 2001, there is a significant "one time" contribution to increased IIT post-2001, as underscored by the increased value of $C_0 + C_2$ compared to the value of C_0 by itself. We shall discuss a possible explanation of this phenomenon in a later section.

The regression results for Buffalo, the second largest customs district, are slightly different from those for Detroit. Specifically, there was a positive and statistically significant trend towards increased IIT through 2001. The trend after 2001 (i.e. the sum of $C_1 + C_3$) is still positive but relatively small in absolute value. The constant term post-2001 is slightly larger than the constant term prior to 2001, although the C_2 coefficient is statistically insignificant. In short, for Buffalo, a modest positive trend for IIT from 1990-2001 appears to have flattened out after 2001.

Results for the other districts are somewhat mixed. For example, the estimated C_2 and C_3 coefficients for Seattle are individually and jointly statistically insignificant. This suggests that IIT

[23] However, Bems, Johnson and Yi (2011) find that the fall in final goods trade globally was more than twice as large as the fall in intermediate goods trade between the first quarter of 2008 and the first quarter of 2009.

patterns of behavior in place prior to 9/11 were essentially unchanged after 9/11. In the cases of both Great Falls and Portland, the estimated C_2 and C_3 coefficients are negative and jointly statistically significant. This result suggests that both constant and trend impacts post-9/11 contributed to reduced IIT in those two districts over the period 2002-2011. Pembina is somewhat similar to Detroit in that there is a strong increase in the constant term after 2001. Both Ogdensburg and St. Albans exhibit smaller constant terms post-2001 with the difference being quite marked for St. Albans. Both also show a higher slope term post-2001. The results for these latter two cases suggest a strong and negative "one-time" post-2001 impact on IIT accompanied by a modest trend influence towards increased IIT.

The change in IIT behavior commencing in 2002 for both overall trade, as well as for individual customs districts, can be illustrated by comparing the fitted values of IIT from 2002-2011 obtained from estimating Equation 1 to the values that are extrapolated from estimating Equation 1 from 1990-2001 and then plugging in values for T_i from 2002-2011. Specifically, the C_0 and C_1 coefficients are estimated for the period 1990-2001, and the resulting equation is used to generate expected values of the dependent variable given the actual values of the T_i variable for 2002-2011.[24] The dotted lines on the graphs in Appendix 3 show these "counterfactual" extrapolations of expected IIT values under the assumption that the 1990-2001 relationship is valid in the period after 2001. The solid line in the graphs shows the fitted values of the IIT when the constant term and slope term are both allowed to change after 2002.[25]

The first graph in Appendix 3 shows the extrapolated and fitted values for the Buffalo customs district. This graph shows a decline in the predicted 2002 IIT value relative to the 1990-2001 extrapolation and a flatter growth path of the trend after 2001. The drop in 2002 reflects a combination of the two regression coefficient results for Buffalo discussed above: an increase in the constant term and a decline in the slope coefficient. The graph for Buffalo in Appendix 3 reveals that the impact of the negative slope shift dominates the increase in the constant term, because the fitted value is lower than the extrapolated value in 2002. The gap between the fitted and extrapolated values grows over time and becomes quite wide by 2011 when the extrapolated value is 0.82 but the fitted value is only 0.48.

The second graph in Appendix 3 shows similar extrapolated and fitted values for the case of the Detroit customs district. The situation in Detroit is in many ways the reverse of that of Buffalo. Detroit shows a slight declining trend from 1990 through 2001 followed by a shift up in 2002. This upward movement in the fitted value is due to an increase in the constant term that has a greater impact than the decline in the slope. The fact that the fitted trend is steeper in the downward direction after 2001 means that the gap between the fitted and extrapolated paths narrows over time for Detroit while it widens for Buffalo. The inverse relationship between the effects of 9/11 for Buffalo and Detroit helps to explain why the 9/11 effect on IIT for all districts combined is relatively small, as shown in the final graph in Appendix 3. In short, the responses of IIT to post-9/11 developments are somewhat offsetting when combining Buffalo and Detroit.

For Great Falls, Pembina and Portland, the comparisons between fitted and extrapolated trends resemble the case of Buffalo more than Detroit. That is, the extrapolated GLI values exceed the fitted values. While the magnitudes of the changes vary somewhat, for Great Falls, Pembina, and

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[24] The graphs contained in Appendix 3 show the relationship between the extrapolated ln GLI values and the values fitted from the regression equations estimated over the full sample period.

[25] The fitted values for the log of the Grubel-Lloyd index are converted back to levels of the index for the graphs in Appendix 3.

Portland, we see a downward shift in 2002 followed by a widening gap in trend lines; Ogdensburg, Seattle and St. Albans resemble Detroit in that the fitted GLI values exceed the extrapolated values. For Seattle, there is a slight upward movement in 2002 but little change in the slope afterward. In essence, IIT was little affected by post-9/11 developments. St Albans shows little shift of the fitted value relative to the extrapolation in 2002, but it does show a widening gap after 2002. In this latter case, the results suggest that IIT was encouraged by post-9/11 developments. The picture for Ogdensburg looks similar to that for St. Albans.

These comparisons of fitted and extrapolated values for the 2002-2011 period help us to understand the regression results from the estimation of Equation 1. Specifically, they provide a graphical illustration of the impact of post-9/11 developments on the share of IIT in total trade. For total bilateral IIT, post-2001 developments appear to have discouraged IIT relative to what might otherwise have been expected, although this difference is modest. Nevertheless, for about half of the customs districts, the estimated values of IIT were actually higher post-2001 than might have been expected, although the differences are small in several cases. In this regard, the graphs identify Detroit and St. Albans as two of the outlier cases. The graphs also point to a possible reversal of fortunes between the Detroit and Buffalo districts. Specifically, IIT for the Buffalo district appears to have been seriously discouraged by post-9/11 developments. Conversely, IIT for the Detroit district was, if anything, boosted by those developments, although the fitted and extrapolated GLI values converge over time. The cases of Detroit and Buffalo are particularly relevant given that they are both major trade corridors in the Great Lakes industrial region.

4.2 Accounting for the Recent Recession

As noted earlier, the severe recession commencing in 2008 resulted in a dramatic collapse in bilateral trade through 2009 (see Table 11) followed by a slow recovery. It took until 2011 for bilateral trade in nominal terms to recover its 2008 level. The substantial decline in bilateral trade associated with the recession might be expected to discourage IIT. As noted earlier, IIT is encouraged by economies of specialization (Shikher, 2011). The latter can be equated to efficiency gains that are realized primarily from longer lengths-of-run for individual products. Export markets, in turn, allow domestic firms to produce and sell greater volumes of specialized products without necessarily depressing the domestic prices of those products. Therefore, to the extent that export markets contract as a consequence of economic recessions, the economic advantages of product specialization are likely to diminish, and IIT's share of trade should decline.

To be sure, severe recessions should also bring about declines in inter-industry trade, as well; however, trade incentives based upon differences in factor endowments are less likely to be impacted by recession than are trade incentives based on longer production lengths-of-run. The implication is that any negative impacts of security-related developments on IIT post-9/11 might "disappear" if Equation 1 is re-estimated with the observations for 2009-2011 deleted from the sample.[26]

The regression results for the shorter sample period are reported in Table 12. When comparing the results in Table 12 to those in Table 10 for the category "All Districts," one notable difference is that the estimated C_2 and C_3 coefficients are individually and jointly statistically significant in Table 10 but individually and jointly insignificant in Table 12. The conclusion one might draw is that the

[26] While the recession is considered to have started in 2008, and economic recovery to have commenced in late 2009, the United States experienced larger than average negative output gaps in 2009-2011. The output gap is the difference between actual real output and potential real output, and it is a standard measure of excess domestic production capacity. Hence, the years 2009-2011 are deleted from the sample.

modest reduction in IIT identified in Table 10 for total bilateral trade in the post-2001 time period primarily reflects the adverse impact of the recent recession on IIT.

For the Detroit customs district, the individually estimated C_2 and C_3 coefficients are statistically insignificant for the truncated time period sample, whereas they are individually statistically significant in the full time period. Furthermore, while the C_2 and C_3 coefficients are jointly statistically significant in both samples, the significance level is lower in the shorter time period. Hence, the recession appears to have modestly discouraged IIT for the Detroit customs district. Nevertheless, the post-2001 behavior of IIT is not fundamentally different when the years 2009-2011 are deleted from the sample.

For the second largest customs district (Buffalo) both the estimated C_2 and C_3 coefficients are individually statistically insignificant in both the truncated and full samples, although they are jointly significant in both samples. The basic behavior of IIT in the post-2001 period therefore remains essentially the same, even after deleting the observations for 2009-2011. The same conclusions can be drawn for Portland. Specifically, while the joint statistical significance of the C_2 and C_3 coefficients declines in the truncated sample, the post-2001 behavior of IIT is essentially the same whether the years 2009-2011 are included or excluded from the sample.

For the Great Falls, Ogdensburg, Pembina and Seattle customs districts, as well, the estimated regression coefficients and their statistical significance are essentially unchanged when comparing results for the full time period to those for the truncated time period. For St. Alban's, the estimated C_2 and C_3 coefficients are quite similar for the two samples, although the two coefficients become jointly insignificant in the shorter time period.

In sum, the impact of post-9/11 developments on IIT are essentially unaffected by inclusion or exclusion of the recent recessionary years from the sample for all customs districts save Detroit. In the latter case, the recession appears to have had a statistically significant negative impact on IIT. The inference one might draw in conjunction with the graph for Detroit in Appendix 3 is that the positive gap observed between the fitted and extrapolated values of IIT in the post-2001 period would have been larger were it not for the negative influence of the recent recession.

Taken as a whole, the recession led to a modest decrease in aggregate IIT, primarily by impacting the structure of trade passing through the Detroit customs district. For other customs districts, the post-9/11 behavior of IIT is basically unchanged even after accounting for the large output gap over the period 2009-2011.

4.3 Overall Summary of Statistical Results

A basic finding of our regression analysis is that the behavior of aggregate bilateral IIT over our sample time period reflects important underlying differences across individual customs districts. Specifically, while post-2001 developments appear to have contributed to a modest reduction in overall bilateral IIT, the phenomenon seems to be attributable to the recession commencing in 2008 rather than to post-9/11 security developments. On balance, the post-2001 behavior of overall bilateral IIT is only slightly different from its pre-2001 behavior. However, the relative constancy of overall bilateral IIT reflects offsetting changes in the behavior of IIT for individual customs districts. In particular, IIT's share of total trade for Detroit appears to have increased in the post-2001 period beyond what might be expected from extrapolations of pre-2001 experience. This phenomenon would have been even greater in the absence of the recession-related output gap discussed above. On the other hand, the experience for Buffalo and several other smaller customs districts are opposite to that for Detroit. That is, post-2001 IIT values are below values expected from pre-2001 experience. Furthermore, the recession does not appear to be a statistically significant contributor to the result.

One possible explanation of Detroit's apparently unique IIT experience post-2001 is the concentration of transportation equipment production in the trade corridor encompassing Ontario and Michigan. In particular, the production of automotive parts and the assembly of automobiles are concentrated in this corridor, and those activities are primarily carried out by large, vertically integrated companies.[27] The latter were arguably better able than most other North American companies to address the higher costs and increased production and distribution scheduling uncertainties created by post-9/11 border security developments.[28] In particular, they were able to take advantage of trusted shipper programs such as FAST sooner and more extensively than smaller, non-integrated companies that rely more heavily upon less-than-truckload shipments. The ostensible result is that trade in differentiated goods actually increased in the post-2001 period relative to what might have been otherwise anticipated given that mitigating border thickening especially promotes IIT relative to inter-industry trade.

To assess whether the automotive sector's IIT experience underlies the aforementioned differences between Detroit and other customs districts, we re-estimated Equation 1 for the four-digit HTS industries that encompass the production of motor vehicles and motor vehicle parts.[29] The results of estimating Equation 1 for these four HTS industries over the full period 1990-2011 are reported in Table 13. For the automotive sector, the estimated C_2 and C_3 coefficients are both positive, albeit individually statistically insignificant; however, the two coefficients are jointly statistically significant. When comparing these results to the results for total bilateral IIT summarized in Table 10, it can be inferred that the IIT experience of the automotive sector in the post-9/11 period is more positive than the experiences of other industries. This is because aggregate bilateral IIT was, if anything, negatively impacted by post-9/11 developments. The idiosyncratic IIT experience for the automotive sector helps explain the difference between the post-2001 behavior of IIT for Detroit and that of other customs districts.[30]

4.4 Conclusions

Our time series analysis indicates that post-9/11 border security developments had no statistically significant impact on overall IIT once the recent recession is accounted for. In part, this result reflects the fact that IIT actually increased in the post-2001 period beyond what might have been expected in the case of Detroit, the largest customs district. This finding for Detroit arguably reflects the prominence of the automotive sector in bilateral trade passing through the Detroit customs district. The vertically integrated automobile companies ostensibly enjoyed structural advantages that better enabled them to cope with border thickening owing to enhanced security and thereby avoid the higher trade costs associated with border thickening. Furthermore, government programs implemented to speed-up commercial border crossings post-9/11 were particularly well suited to the economic circumstances of the automotive industry. The outcome is that aggregate bilateral IIT was relatively unchanged in the post-2001 period compared to the period 1990-2001, although substantial post-2001 "shortfalls" can be identified for several customs districts, most notably Buffalo.

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[27] In 2001, automobiles and automotive parts accounted for around one-third of the total U.S. trade with Canada passing through the Detroit customs district.

[28] Justifications for this assertion, as well as some supportive evidence, are provided in Globerman and Storer (2012).

[29] These are HTS 8703, 8706, 8707 and 8708.

[30] Yi (2010) provides, additional evidence suggesting that vertically integrated North American automobile manufacturers enjoy lower effective border costs than other North American manufacturers.

5.0 Overview of Patterns of Trade in Intermediate and Final Goods

In this section we separate trade flows into intermediate and final goods categories to further examine the linkages between post-9/11 developments and the nature of Canada-U.S. trade. Intermediate goods trade is of particular interest given the key role that cross-border trade in intermediate goods plays in deepening bilateral production linkages. To the extent that cross-border clusters have developed, we would expect to see a heightened level of trade in intermediate goods as vertical specialization of production intensifies. Furthermore, trade within clusters should, as discussed earlier, involve a high level of IIT[31]. Intermediate goods IIT trade is particularly interesting from a policy viewpoint because increased border security could be particularly costly for industries where production of final goods involves multiple border crossings for specialized intermediate stage production.

5.1 Classifying Products

To classify goods as intermediate or final, we rely upon the Broad Economic Categories (BEC) codes developed by the United Nations. The UN provides a classification of the BEC codes identifying intermediate and final goods, and this classification has been used in a number of previous studies such as Bergstrand and Egger (2010). In order to apply the BEC classifications at the customs district level for the 1990-2011 period, we downloaded trade data at the 5-digit SITC level from the USITC DataWeb site and then used a UN correspondence table to aggregate the SITC data into BEC categories which could then be separated into final and intermediate goods.

Table 14 provides an overview of the composition of Canada-U.S. bilateral non-fuel trade (exports plus imports) for the eight main northern-border customs districts, as well as for all districts combined. The table shows the average share of intermediate goods in total bilateral non-fuel trade for three separate time periods: the full 1990-2011 time period, the pre-9/11 period (1990-2000) and the post-9/11 period (2002-2011). For the full sample period, the average intermediate goods share varies from a low of 47 percent at Buffalo to a high of 68 percent at St Albans. In most cases, the share of intermediate goods is close to 55 percent. When comparing the share of intermediate goods in the 1990-2001 period to that in the 2002-2011 period, the share rises slightly for Great Falls and Ogdensburg. It declines modestly for four districts (Buffalo, Detroit, Portland, and Seattle) and sharply for St Albans. The share remains constant for Pembina. Reflecting the larger sizes of the Detroit and Buffalo customs districts, intermediate goods as a share of total non-fuel bilateral trade decreases between the two sub-periods.

It is perhaps surprising that the Detroit and Buffalo customs districts don't have the highest values for the share of intermediate goods trade in total trade. Detroit in particular is associated with the North American automotive sector in which a large share of production is carried out by vertically integrated firms operating cross-border supply chains. The relatively low value for the share of intermediate goods trade at Detroit could reflect the fact that the 5-digit SITC classifications place products from different stages of the automotive-sector value chain into different SITC categories, thereby masking the true extent of intermediate goods trade for that customs district. Also, given that there is a significant volume of Canada-U.S. trade in finished automobiles, this finished-goods trade will increase the value of the final-goods category relative to intermediate goods. Furthermore,

[31] In practice, this assertion isn't quite as tautological as it sounds. If goods are classified more by their stage in the vertical production process rather than by the industry of the ultimate final product, then intra-industry trade measures may not reveal actual within-cluster integration. The point here is that measured IIT might understate industrial clustering.

the importance of Mexico as a location for automobile parts production grew over our sample period which might have particularly and adversely affected intermediate goods trade carried out through the Detroit customs district.

Once every 5-digit nonfuel SITC code was classified as either a final or intermediate good, we were able to calculate district-level GLI values of IIT separately for final and intermediate goods. Hence, IIT in intermediate goods can be interpreted as the share of total intermediate goods trade consisting of differentiated intermediate goods, while IIT in final goods is the share of total final goods trade consisting of differentiated final goods.

The graphs in Appendix 4 show final and intermediate goods' GLI values for the eight northern-border districts, as well as for all districts combined. One interesting pattern that is suggested by the graphs is that the IIT values are more volatile for final goods than for intermediate goods in the case of the Buffalo and Detroit customs districts, whereas the pattern is less evident for other districts. This difference could reflect the fact that for Detroit and Buffalo, IIT in specialized intermediate goods reflects deeply integrated cross-border production relationships. Such deep relationships might persist over time, even in the face of significant border thickening, given the difficulty of restructuring regional supply chains. There is also some evidence from the graphs that the GLI values for final goods trade in Buffalo and Detroit were impacted in opposite directions over the 1995-2002 period. Specifically, the movement of IIT in final goods for Buffalo appears to be a mirror image of the movement of IIT for Detroit over that period.

The IIT graphs for Seattle, Portland and Ogdensburg also show a greater volatility for final goods trade than for trade in intermediate goods, although the difference seem less pronounced for these three districts than it is for Buffalo and Detroit. For Great Falls and Pembina, the GLI series show similar patterns for both intermediate and final goods. Finally, for St Albans, the GLI values are much higher in both level and volatility for intermediate goods compared to final goods.

Some additional evidence on volatility of IIT values for intermediate and final goods is provided by the data reported in Table 15. Specifically, the table reports the ratio of the standard deviation to the mean of the GLI values calculated for 1990-2011. As discussed in referring to Table 7, this ratio is a conventional way of comparing the volatility of time series when the series being compared differ in absolute values. The ratios show that the volatility of GLI is generally greater for final goods than for intermediate goods.

The ratios reported in Table 15 show that the GLI values for intermediate goods are relatively stable in the cases of Buffalo and Detroit compared to most other customs districts. Furthermore, they are relatively stable compared to the GLI values for final goods for those same two districts. On the other hand, the relative variability of final goods' GLI values for Buffalo exceeds that of most other customs districts, while the relative variability measure for Detroit is only exceeded by measures for St. Albans and Buffalo, and it is virtually identical to the measures for Pembina and Portland. Clearly, IIT for final goods is substantially more subject to variation over time than is IIT for intermediate goods.

The fact that GLI volatilities for aggregate bilateral intermediate and final goods trade are well below values for most individual customs districts suggests that relatively large changes in GLI values are somewhat offsetting across the individual districts. That is, large changes for some districts are matched by small changes in other districts in any given year, again underscoring the point that bilateral trade patterns can vary significantly across regional trade corridors.

5.2 Regression Analysis

To identify whether the time series behavior of IIT differs between intermediate and final goods, we re-estimate Equation 1 separately for the two goods categories. Detailed regression coefficient results are in Tables 16 and 17. Appendix 5 provides graphs similar to those in Appendix 3 showing the extrapolated GLI values and the fitted values from 2002 through 2011. Specifically, the graphs show the difference between the extrapolated and fitted GLI values for final and intermediate goods for the time period 2002-2011.

It is first useful to compare Tables 10 and 16. A comparison of the reported coefficients in the two tables shows some comparability in the signs of the C_2 and C_3 coefficients, as well as in the magnitudes of their values. For five of the eight customs districts, the C_2 and C_3 coefficients are jointly statistically significant in both tables. However, they are jointly statistically insignificant in Table 16 for aggregate trade and for the Great Falls district, while they are jointly statistically insignificant in Table 10 for the Seattle district. In short, the regression results for final goods are quite comparable to those for all goods.

There are slightly more marked differences in the estimated C_2 and C_3 coefficients when comparing results reported in Tables 10 and 17, that is, when comparing the regression results for all goods to those for intermediate goods. In this latter case, four of the customs districts (Great Falls, Ogdensburg, Portland and Seattle) have a different estimated C_2 and/or C_3 coefficient in estimated equations for intermediate goods compared to the estimated coefficients for all goods; however, the C_2 and C_3 coefficients are not jointly statistically significant in the cases of Ogdensburg and Seattle. The inference one might draw is that there are modest differences in the time series behavior of IIT for intermediate goods versus IIT for final goods.

The differences in IIT behavior for final goods versus intermediate goods are illustrated by the graphs in Appendix 5. The graphs show extrapolated and fitted values for IIT for intermediate and final goods where those values are calculated in the same way as they were to construct the graphs reported in Appendix 3. It is again useful to compare the results for all traded goods to those for final and intermediate goods separately. That is, it is useful to compare the graphs in Appendix 3 to those in Appendix 5.

In the case of Buffalo, the extrapolated value of IIT exceeds the fitted value for all traded goods, as well as for intermediate and final goods; however, the gap between the fitted and extrapolated IIT values is larger in the case of final goods than in the case of intermediate goods.[32] Put simply, post-9/11 border thickening particularly and adversely affected IIT in final goods passing through the Buffalo district. In the case of Detroit, the extrapolated values for IIT relative to their fitted value are comparable for total, intermediate and final goods trade through 2005. Starting in 2006, the extrapolated values for IIT for intermediate goods exceed the fitted values. This result suggests that border thickening may have discouraged the growth of IIT for intermediate goods; however we are more inclined to interpret the sharp decline in the fitted IIT values post-2006 to the recession which, apparently had a particularly severe impact on IIT in intermediate goods.[33]

The behavior of IIT for Great Falls also shows a discrepancy between the intermediate and final goods experiences. Specifically, the extrapolated values for IIT for intermediate goods exceed the

[32] It should be explicitly noted that we did not constrain the extrapolated value of IIT to a maximum of unity, which, of course, is the maximum economic value that it can take.

[33] The growing importance of Mexico as a supplier of intermediate automotive products to the U.S. might also be implicated.

fitted values, whereas the reverse is true for IIT for final goods. Hence, the post-9/11 "shortfall" for IIT in the case of total trade passing through Great Falls reflects a shortfall for intermediate goods IIT. The same discrepancy is identified for Ogdensburg, although the extrapolated and fitted IIT values for total trade are quite similar over the post-2001 period.

In the case of Pembina, the intermediate and final goods IIT behaviors are quite comparable when comparing extrapolated versus fitted values post-2001. The same conclusion can be drawn for St. Albans with modest reservation. However, in the case of Portland, the gap between extrapolated and fitted IIT values for total trade primarily reflects a similar gap for final goods trade. There is essentially no difference between post-2001 extrapolated and fitted IIT values in the case of intermediate goods. The same inference can be drawn for Seattle.

If we compare the graphs for total bilateral trade, the post-2001 gap between extrapolated and fitted IIT values for all goods looks quite comparable to the post-2001 gap for intermediate goods reflecting the importance of the previously discussed behavior of intermediate goods IIT for Detroit. In the case of final goods, there is very little difference between the post-2001 extrapolated and fitted values for IIT.

5.3 Summary of Statistical Results

A statistical analysis of the time series behavior of IIT for intermediate and final goods as separate categories again reveals differences in the experiences of individual customs districts. Specifically, for some customs districts, there is a greater post-9/11 impact on IIT for final goods, while for others the impact is greater for intermediate goods. For all districts in the aggregate, the post-9/11 impact is larger for intermediate goods than for final goods, although the impacts are relatively small in both cases.

Separate estimation of IIT behavior for intermediate versus final goods also reveals that for some individual customs districts, changes in IIT over time for all goods mask different patterns for intermediate and final goods. For example, while there appears to be an IIT shortfall for intermediate goods in the case of Detroit, the fitted IIT value for final goods exceeds the extrapolated value post-2001 which is also the case for all goods shipped through Detroit. Similarly, the extrapolated IIT values exceed the fitted values for intermediate goods in the case of Great Falls and Ogdensburg, whereas the reverse is true for final goods. However, for other customs districts, the observed gaps between the fitted and the extrapolated IIT values are similar for both intermediate and final goods. For example, in the case of Buffalo, the extrapolated IIT values exceed the fitted values for both intermediate and final goods.

5.4 Overall Summary

In the preceding section, we considered whether the time series behavior of the Grubel-Lloyd index is similar for intermediate and final goods. It seems likely that producers are more sensitive than final consumers to higher prices. Hence, to the extent that imports of both intermediate and final goods increase in price because of border thickening, one might expect IIT for intermediate goods to decrease relative to IIT for final goods. This assumes that the prices of differentiated intermediate goods increase by about the same proportionate amount as prices of differentiated final goods. Indeed, IIT shortfalls in the post-2001 period appear more substantial for intermediate goods than for final goods across most customs districts. Buffalo is a notable exception to this observation. In this case, the post-2001 IIT shortfall is much larger for final goods than for intermediate goods. Pembina, Portland and Seattle also exhibit IIT shortfalls for final goods that tend to be somewhat larger than the IIT shortfalls for intermediate goods.

6.0 Overall Summary and Conclusions

Most of the policy-related literature on border thickening in the Canada-U.S. context has focused on overall cross-border trade flows. This study focuses on whether and how post-9/11 border security developments may have affected the nature of bilateral trade. In particular, it presents and evaluates statistical evidence regarding the behavior of intra-industry trade (IIT) over the period 1990-2011.

Observers of the bilateral trade process have identified the growth of IIT as a share of total bilateral trade as a prominent feature of Canada-U.S. trade during the 1970's and 1980's. However, it has also been noted that the growth of bilateral IIT stagnated in the 1990's, such that the share of total bilateral trade that is IIT is not much different today than it was in the early 1990's. This finding is somewhat surprising given major trade liberalization initiatives that were undertaken, including the Canada-U.S. Free Trade Agreement that was implemented in 1989. Hence, one purpose of this study is to assess whether the post-1990 IIT pattern reflects border thickening initiatives implemented post-9/11 which in other studies have been found to have contributed to overall bilateral trade "shortfalls."[34]

A statistical analysis of IIT was undertaken for total bilateral trade, as well as for eight northern customs districts. The analysis sought to identify whether a continuation of the pre-2001 time series patterns for IIT would have resulted in higher IIT values than were estimated from the full time series including post-2001 years. In undertaking the analysis, the anticipated adverse impact of the recent severe recession was also taken into account. We found that post-9/11 developments did result in lower overall values of IIT than would have been expected given an extrapolation of pre-9/11 time series patterns; however, the severe recession in the latter part of the time period contributes substantially to this result. Indeed, holding the impact of the recession constant, the overall impact of post-9/11 developments on bilateral IIT was statistically insignificant. However, this overall result masks different experiences across the individual customs districts.

Hence, one notable finding is that the IIT experiences of individual customs districts differ substantially. For example, whereas IIT for the Detroit district actually seems to increase, at least initially, in the post-2001 period, IIT seems to suffer post-2001 in most other customs districts. This is particularly true for Buffalo, where IIT, especially for finished goods, falls well below its extrapolated value post-2001. Given the large relative size of the Detroit district, it is clear that overall bilateral IIT would have decreased significantly in the post-2001 period were it not for the adjustments that the large auto manufacturers were able to make to the border thickening security developments following the terrorist attacks of 9/11.

Our analysis also highlights differences across customs districts in the impacts of border thickening on IIT for intermediate versus final goods. Specifically, for several districts, most notably Buffalo, the major impact of post-9/11 border thickening was on IIT in final goods. For other districts, the major impact was on IIT in intermediate goods.

Therefore, an important conclusion of our study is that changes in aggregate patterns of bilateral trade may obscure prominent differences in patterns for individual trade corridors. Indeed, in the case of IIT, there are marked differences in the post-2001 experiences of the two largest customs districts, i.e. Detroit and Buffalo.

[34] Andresen (2003) argues that barriers to trade will particularly hinder IIT.

A potential shortcoming of our study is that we do not specify and estimate structural models of IIT. Rather, we rely solely on time series analysis. The upshot is that we cannot explain why IIT for aggregate trade in 2011 was about the same as it was in 1990, even though the growth in real incomes in both countries, along with trade liberalization, should have encouraged an increase in aggregate IIT over that time period, other things constant. It is possible that the adverse impact of border thickening on IIT would have been more noticeable had North American governments not implemented Trusted Shipper programs that, in particular, mitigated security-related border thickening for the major North American automobile manufacturers.

Another shortcoming is that we do not explain differences in IIT time-series behavior across trade corridors. In particular, we do not explain why the Buffalo customs district experienced a relatively large IIT shortfall in finished goods post-9/11, while Detroit did not. It is likely that the concentration of automotive-related trade in the Detroit corridor is part of the explanation, although a full explanation requires further study.

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Table 1
Grubel-Lloyd Index

Time Period	4-digit	6-digit	8-digit	10-digit
1990-1995	.497	.438	.307	.156
1996-2000	.517	.455	.318	.169
2001-2005	.510	.447	.321	.160
2006-2011	.487	.429	.293	.159

Source: Authors' calculations from the U.S. Government's Data Web at http://dataweb.usitc.gov

Table 2
GLI Values Based on HTS 6-digit Data

Year	GLI
1990	0.45
1991	0.44
1992	0.43
1993	0.43
1994	0.44
1995	0.43
1996	0.45
1997	0.47
1998	0.47
1999	0.45
2000	0.44
2001	0.44
2002	0.45
2003	0.45
2004	0.45
2005	0.45
2006	0.45
2007	0.46
2008	0.43
2009	0.41
2010	0.41
2011	0.41

Table 3
Fraction of Total U.S.-Canada Trade Contributed by District

District	1990	2011
Buffalo	0.19	0.13
Detroit	0.37	0.35
Great Falls	0.03	0.06
Ogdensburg	0.09	0.07
Pembina	0.04	0.07
Portland	0.02	0.02
Seattle	0.05	0.05
St. Albans	0.05	0.02
Total	0.85	0.77

Table 4
IIT Values Based on HTS 6-digit Data

Year	All	Buffalo	Detroit	Great Falls	Ogdensburg	Pembina	Portland	Seattle	St. Albans
1990	0.45	0.37	0.47	0.12	0.38	0.14	0.12	0.25	0.58
1991	0.44	0.35	0.44	0.10	0.32	0.12	0.09	0.24	0.47
1992	0.43	0.36	0.42	0.09	0.39	0.12	0.11	0.22	0.44
1993	0.43	0.33	0.45	0.09	0.32	0.14	0.12	0.22	0.40
1994	0.44	0.35	0.44	0.10	0.31	0.16	0.14	0.24	0.35
1995	0.43	0.47	0.38	0.12	0.31	0.20	0.14	0.24	0.38
1996	0.45	0.51	0.40	0.13	0.30	0.22	0.15	0.24	0.37
1997	0.47	0.53	0.41	0.14	0.30	0.23	0.15	0.24	0.22
1998	0.47	0.50	0.44	0.14	0.30	0.24	0.16	0.24	0.26
1999	0.45	0.52	0.43	0.13	0.31	0.26	0.16	0.24	0.31
2000	0.44	0.52	0.43	0.13	0.31	0.23	0.16	0.21	0.27
2001	0.44	0.45	0.46	0.12	0.29	0.23	0.15	0.21	0.18
2002	0.45	0.38	0.51	0.11	0.29	0.23	0.14	0.24	0.18
2003	0.45	0.42	0.51	0.11	0.29	0.24	0.13	0.24	0.17
2004	0.45	0.44	0.50	0.12	0.30	0.23	0.13	0.23	0.26
2005	0.45	0.45	0.51	0.11	0.27	0.21	0.13	0.22	0.30
2006	0.45	0.45	0.51	0.12	0.26	0.22	0.13	0.23	0.21
2007	0.46	0.48	0.50	0.12	0.28	0.22	0.14	0.23	0.18
2008	0.43	0.48	0.49	0.13	0.27	0.22	0.15	0.21	0.18
2009	0.41	0.47	0.46	0.13	0.29	0.22	0.16	0.23	0.21
2010	0.41	0.44	0.44	0.12	0.28	0.23	0.15	0.22	0.24
2011	0.41	0.46	0.43	0.14	0.30	0.21	0.15	0.22	0.23

Table 5
Correlation Coefficients of GLI Values

HTS 6	All	Buffalo	Detroit	Great Falls	Ogdensburg	Pembina	Portland	Seattle	St. Alban's
All	1.00	0.23	0.20	0.08	0.01	0.19	-0.06	0.40	0.02
Buffalo	0.23	1.00	-0.21	0.85	-0.46	0.79	0.73	-0.14	-0.49
Detroit	0.20	-0.21	1.00	-0.19	-0.37	0.19	-0.16	-0.09	-0.42
Great Falls	0.08	0.85	-0.19	1.00	-0.38	0.70	0.75	0.02	-0.42
Ogdensburg	0.01	-0.46	-0.37	-0.38	1.00	-0.70	-0.50	0.23	0.81
Pembina	0.19	0.79	0.19	0.70	-0.70	1.00	0.80	-0.07	-0.77
Portland	-0.06	0.73	-0.16	0.75	-0.50	0.80	1.00	-0.17	-0.59
Seattle	0.40	-0.14	-0.09	0.02	0.23	-0.07	-0.17	1.00	0.41
St. Alban's	0.02	-0.49	-0.42	-0.42	0.81	-0.77	-0.59	0.41	1.00

Table 6
Average GLI Values Pre and Post-2001

	Average GLI 1990-2001	Average GLI 2002-2011
All	.445	.437
Buffalo	.438	.447
Detroit	.431	.486
Great Falls	.118	.121
Ogdensburg	.320	.283
Pembina	.191	.223
Portland	.138	.141
Seattle	.233	.227
St. Albans	.353	.216

Table 7
Tabulated Values: MIIT Based on HTS 6-digit Data

	All	Buffalo	Detroit	Great Falls	Ogdensburg	Pembina	Portland	Seattle	St. Albans
1991	0.27	0.20	0.22	0.06	0.23	0.07	0.05	0.13	0.11
1992	0.27	0.26	0.28	0.07	0.18	0.08	0.04	0.11	0.31
1993	0.27	0.18	0.34	0.09	0.18	0.08	0.09	0.10	0.25
1994	0.25	0.17	0.26	0.06	0.15	0.10	0.07	0.11	0.10
1995	0.23	0.12	0.17	0.06	0.18	0.08	0.10	0.11	0.26
1996	0.37	0.26	0.22	0.10	0.20	0.12	0.10	0.17	0.58
1997	0.32	0.21	0.22	0.12	0.19	0.15	0.10	0.17	0.10
1998	0.19	0.12	0.18	0.11	0.15	0.16	0.06	0.12	0.09
1999	0.27	0.21	0.25	0.06	0.26	0.16	0.13	0.11	0.08
2000	0.21	0.15	0.16	0.09	0.21	0.14	0.11	0.09	0.10
2001	0.27	0.36	0.21	0.07	0.22	0.13	0.06	0.12	0.19
2002	0.35	0.19	0.28	0.11	0.20	0.17	0.10	0.12	0.33
2003	0.19	0.18	0.20	0.07	0.16	0.10	0.08	0.09	0.06
2004	0.25	0.22	0.20	0.12	0.20	0.13	0.09	0.11	0.15
2005	0.30	0.19	0.32	0.07	0.14	0.14	0.06	0.13	0.23
2006	0.24	0.24	0.21	0.15	0.15	0.13	0.09	0.11	0.27
2007	0.38	0.30	0.39	0.12	0.20	0.14	0.10	0.13	0.50
2008	0.26	0.29	0.27	0.11	0.10	0.11	0.10	0.10	0.07
2009	0.31	0.29	0.36	0.09	0.15	0.14	0.08	0.12	0.07
2010	0.28	0.20	0.29	0.08	0.14	0.13	0.07	0.12	0.04
2011	0.26	0.20	0.21	0.15	0.18	0.14	0.12	0.13	0.11

Summary Statistics

District	Mean	Std. Dev.
All	0.27	0.05
Buffalo	0.22	0.06
Detroit	0.25	0.06
Great Falls	0.09	0.03
Ogdensburg	0.18	0.03
Pembina	0.12	0.03
Portland	0.09	0.02
Seattle	0.12	0.02
St Albans	0.19	0.15

Table 8
Correlations between District-level MIIT Values

	All	Buffalo	Detroit	Great Falls	Ogdensburg	Pembina	Portland	Seattle	St. Albans
All	1.00	0.50	0.60	0.19	0.20	0.27	0.12	0.70	0.65
Buffalo	0.50	1.00	0.41	0.16	0.06	0.11	-0.08	0.23	0.27
Detroit	0.60	0.41	1.00	0.00	-0.18	0.06	-0.09	0.04	0.26
Great Falls	0.19	0.16	0.00	1.00	-0.21	0.47	0.43	0.26	0.18
Ogdensburg	0.20	0.06	-0.18	-0.21	1.00	0.11	0.25	0.22	0.22
Pembina	0.27	0.11	0.06	0.47	0.11	1.00	0.46	0.27	-0.05
Portland	0.12	-0.08	-0.09	0.43	0.25	0.46	1.00	0.05	0.02
Seattle	0.70	0.23	0.04	0.26	0.22	0.27	0.05	1.00	0.43
St. Albans	0.65	0.27	0.26	0.18	0.22	-0.05	0.02	0.43	1.00

Table 9
Correlation Coefficients of IIT and MIIT 1990-2011

HTS 6	Correlation Coefficients
All	.08
Buffalo	.09
Detroit	.33
Great Falls	.47
Ogdensburg	.37
Pembina	.77
Portland	.58
Seattle	.26
St. Alban’s	.17

Table 10
Regression Results 1990-2011

District	Coef.	Estimate	Std. Error	T-value	Pr(>|t|)	R^2	Pr(>|*F*|)
All	c_0	-0.8212	0.0152	-54.0856	0.0000 *	0.5159	0.0054 *
	c_1	0.0020	0.0023	0.8620	0.4000		
	c_2	0.1945	0.0537	3.6183	0.0020 *		
	c_3	-0.0143	0.0039	-3.6960	0.0017 *		
Buffalo	c_0	-1.0712	0.0533	-20.0989	0.0000 *	0.6134	0.0016 *
	c_1	0.0418	0.0082	5.0969	0.0001 *		
	c_2	0.0077	0.1887	0.0411	0.9677		
	c_3	-0.0265	0.0136	-1.9502	0.0669		
Detroit	c_0	-0.8308	0.0277	-30.0062	0.0000 *	0.7051	0.0001 *
	c_1	-0.0024	0.0043	-0.5699	0.5758		
	c_2	0.4184	0.0980	4.2688	0.0005 *		
	c_3	-0.0163	0.0070	-2.3125	0.0328 *		
Great Falls	c_0	-2.2957	0.0514	-44.6627	0.0000 *	0.5220	0.0117 *
	c_1	0.0288	0.0079	3.6369	0.0019 *		
	c_2	-0.2270	0.1820	-1.2477	0.2281		
	c_3	-0.0036	0.0131	-0.2730	0.7879		
Ogdensburg	c_0	-1.0449	0.0321	-32.5068	0.0000 *	0.6604	0.1286
	c_1	-0.0187	0.0050	-3.7863	0.0014 *		
	c_2	-0.1927	0.1138	-1.6935	0.1076		
	c_3	0.0172	0.0082	2.1017	0.0499 *		
Pembina	c_0	-2.0753	0.0563	-36.8629	0.0000 *	0.8234	0.0000 *
	c_1	0.0703	0.0087	8.1142	0.0000 *		
	c_2	0.7115	0.1993	3.5701	0.0022 *		
	c_3	-0.0788	0.0143	-5.4945	0.0000 *		
Portland	c_0	-2.2447	0.0509	-44.1230	0.0000 *	0.6567	0.0010 *
	c_1	0.0431	0.0078	5.4962	0.0000 *		
	c_2	-0.0177	0.1801	-0.0985	0.9226		
	c_3	-0.0250	0.0130	-1.9306	0.0694		
Seattle	c_0	-1.4254	0.0246	-57.9792	0.0000 *	0.2858	0.3883
	c_1	-0.0064	0.0038	-1.6836	0.1095		
	c_2	0.0765	0.0870	0.8793	0.3908		
	c_3	-0.0019	0.0063	-0.3011	0.7668		
St. Alban's	c_0	-0.6442	0.0943	-6.8329	0.0000 *	0.7946	0.0044 *
	c_1	-0.0811	0.0145	-5.5868	0.0000 *		
	c_2	-1.0864	0.3337	-3.2555	0.0044 *		
	c_3	0.0921	0.0240	3.8376	0.0012 *		

* Significantly different from zero at .95 confidence level.

Table 11
U.S. Trade in Goods with Canada (Billions of U.S. $)

Year	Exports	Imports	Balance
1985	47.3	69.0	-21.7
1987	59.8	71.1	-11.3
1989	78.8	88.0	-9.2
1991	85.2	91.1	-5.9
1993	100.4	111.2	-10.8
1995	127.2	144.4	-17.2
1997	151.8	167.2	-15.4
1999	166.6	198.7	-32.7
2001	163.4	216.3	-52.9
2003	169.9	221.6	-51.7
2005	211.9	290.4	-78.5
2007	248.9	317.1	-68.2
2009	204.7	226.2	-21.5
2011	280.9	315.3	-34.4

Source: U.S. Census Bureau, Foreign Trade-U.S. Trade with Canada, http://www.census.gov/foreign-trade/balance/c1220.html

Table 12
Regression Results 1990-2008

District	Coef.	Estimate	Std. Error	T-value	Pr(>|t|)	R^2	Pr(>|*F*|)
All	c_0	-0.8212	0.0135	-60.7047	0.0000 *	0.0976	0.6855
	c_1	0.0020	0.0021	0.9675	0.3486		
	c_2	0.0546	0.0725	0.7533	0.4629		
	c_3	-0.0044	0.0051	-0.8547	0.4062		
Buffalo	c_0	-1.0712	0.0552	-19.4003	0.0000 *	0.6479	0.0033 *
	c_1	0.0418	0.0085	4.9197	0.0002 *		
	c_2	-0.2634	0.2960	-0.8899	0.3876		
	c_3	-0.0075	0.0210	-0.3556	0.7271		
Detroit	c_0	-0.8308	0.0276	-30.0734	0.0000 *	0.7492	0.0026 *
	c_1	-0.0024	0.0043	-0.5712	0.5763		
	c_2	0.2253	0.1481	1.5215	0.1489		
	c_3	-0.0028	0.0105	-0.2624	0.7966		
Great Falls	c_0	-2.2957	0.0546	-42.0729	0.0000 *	0.4803	0.0213 *
	c_1	0.0288	0.0084	3.4260	0.0038 *		
	c_2	-0.2607	0.2925	-0.8913	0.3868		
	c_3	-0.0012	0.0208	-0.0571	0.9552		
Ogdensburg	c_0	-1.0449	0.0331	-31.5544	0.0000 *	0.6807	0.5998
	c_1	-0.0187	0.0051	-3.6754	0.0022 *		
	c_2	-0.0367	0.1775	-0.2067	0.8390		
	c_3	0.0063	0.0126	0.4978	0.6258		
Pembina	c_0	-2.0753	0.0606	-34.2623	0.0000 *	0.8244	0.0005 *
	c_1	0.0703	0.0093	7.5417	0.0000 *		
	c_2	0.8312	0.3247	2.5600	0.0218 *		
	c_3	-0.0873	0.0231	-3.7862	0.0018 *		
Portland	c_0	-2.2447	0.0543	-41.3301	0.0000 *	0.6428	0.0023 *
	c_1	0.0431	0.0084	5.1483	0.0001 *		
	c_2	0.0542	0.2911	0.1861	0.8548		
	c_3	-0.0303	0.0207	-1.4652	0.1635		
Seattle	c_0	-1.4254	0.0257	-55.4336	0.0000 *	0.3144	0.2437
	c_1	-0.0064	0.0040	-1.6097	0.1283		
	c_2	0.1986	0.1378	1.4406	0.1703		
	c_3	-0.0105	0.0098	-1.0720	0.3007		
St. Alban's	c_0	-0.6442	0.1013	-6.3586	0.0000 *	0.7924	0.1227
	c_1	-0.0811	0.0156	-5.1990	0.0001 *		
	c_2	-0.8424	0.5431	-1.5512	0.1417		
	c_3	0.0750	0.0386	1.9461	0.0706		

* Significantly different from zero at .95 confidence level.

Table 13
Regression Results for HTS 8703, 8706-8708: 1990-2011

Coefficients	Estimate	St. Error	t-Value
C_0	-.1198	.028	-4.256
C_1	-.0280	.004	-6.454
C_2	.1328	.100	1.333
C_3	.0082	.007	1.141

Adjusted R-Squared = 0.720
F – Statistic = 18.98

Table 14
Share of Intermediate Goods in Bilateral Trade (Exports plus Imports)

District	1990-2011 Average	1990-2000 Average	2002-2011 Average
All Districts	53%	55%	52%
Buffalo	47%	47%	46%
Detroit	52%	54%	51%
Great Falls	52%	52%	53%
Ogdensburg	64%	63%	65%
Pembina	57%	57%	57%
Portland	49%	50%	47%
Seattle	56%	57%	55%
St Albans	68%	76%	60%

Table 15
Grubel-Lloyd Index – Relative Volatility for Intermediate and Final Goods Expressed as a Percentage

District	Intermediate Goods: St. Dev/Mean	Final Goods: St. Dev/Mean
All Districts	3.9%	6.6%
Buffalo	4.4%	24.6%
Detroit	5.7%	20.9%
Great Falls	24.4%	13.5%
Ogdensburg	5.3%	14.6%
Pembina	21.9%	20.6%
Portland	9.4%	20.6%
Seattle	7.2%	12.6%
St. Albans	24.5%	34.6%

Table 16
Regression Results for Final Goods: 1990-2011

District	Coefficient	Estimate	Std Error	t value	Pr(> |t|)		R^2	Pr(>f)	
All	$c0$	-0.7837	0.0326	-24.0063	0.0000	*	0.2616	0.1169	
	$c1$	0.0007	0.0050	0.1426	0.8882				
	$c2$	0.2301	0.1156	1.9913	0.0618				
	$c3$	-0.0114	0.0083	-1.3719	0.1869				
Buffalo	$c0$	-1.1986	0.1059	-11.3170	0.0000	*	0.5368	0.0039	*
	$c1$	0.0725	0.0163	4.4451	0.0003	*			
	$c2$	0.0650	0.3749	0.1734	0.8643				
	$c3$	-0.0508	0.0270	-1.8845	0.0757				
Detroit	$c0$	-0.9411	0.0733	-12.8317	0.0000	*	0.6665	0.0002	*
	$c1$	-0.0232	0.0113	-2.0573	0.0544				
	$c2$	0.7349	0.2596	2.8306	0.0111	*			
	$c3$	-0.0110	0.0187	-0.5907	0.5621				
Great Falls	$c0$	-1.4742	0.0692	-21.3046	0.0000	*	0.2217	0.1382	
	$c1$	-0.0150	0.0107	-1.4118	0.1751				
	$c2$	0.0870	0.2449	0.3554	0.7264				
	$c3$	0.0105	0.0176	0.5965	0.5583				
Ogdensburg	$c0$	-0.7571	0.0504	-15.0353	0.0000	*	0.5622	0.0017	*
	$c1$	-0.0358	0.0078	-4.6140	0.0002	*			
	$c2$	-0.4173	0.1783	-2.3412	0.0309	*			
	$c3$	0.0474	0.0128	3.6967	0.0017	*			
Pembina	$c0$	-1.7292	0.0882	-19.6166	0.0000	*	0.4884	0.0024	*
	$c1$	0.0514	0.0136	3.7849	0.0014	*			
	$c2$	0.5031	0.3120	1.6123	0.1243				
	$c3$	-0.0703	0.0224	-3.1324	0.0058	*			
Portland	$c0$	-2.1282	0.0810	-26.2798	0.0000	*	0.7142	0.0009	*
	$c1$	0.0754	0.0125	6.0435	0.0000	*			
	$c2$	0.6593	0.2867	2.2998	0.0336	*			
	$c3$	-0.0790	0.0206	-3.8304	0.0012	*			
Seattle	$c0$	-1.3760	0.0516	-26.6441	0.0000	*	0.5754	0.0011	*
	$c1$	0.0387	0.0080	4.8692	0.0001	*			
	$c2$	0.3582	0.1828	1.9592	0.0658				
	$c3$	-0.0468	0.0131	-3.5610	0.0022	*			
St. Alban's	$c0$	-1.9141	0.0708	-27.0477	0.0000	*	0.8630	0.0003	*
	$c1$	-0.0632	0.0109	-5.7975	0.0000	*			
	$c2$	-1.2553	0.2505	-5.0108	0.0000	*			
	$c3$	0.0886	0.0180	4.9166	0.0001	*			

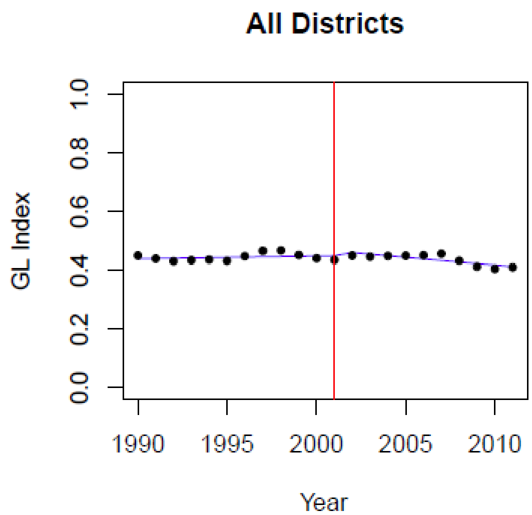
* Indicates statistical significance at .05 level.

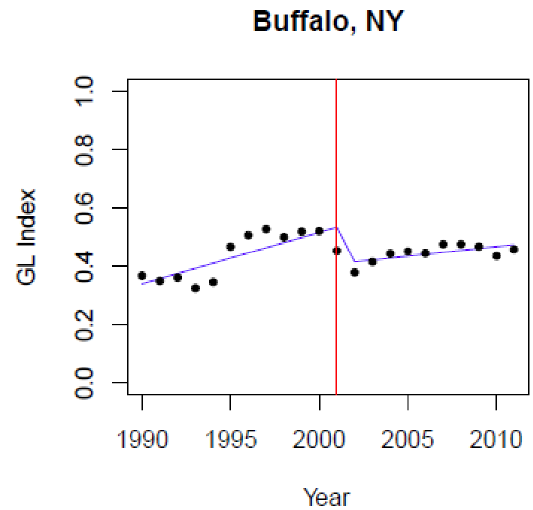
Table 17
Regression Results for Intermediate Goods: 1990-2011

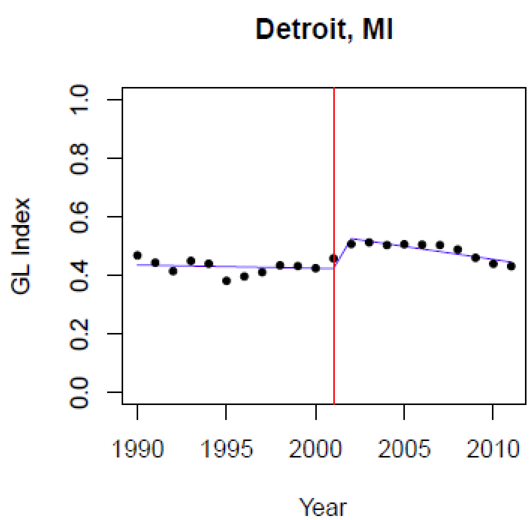
District	Coefficient	Estimate	Std Error	t value	Pr(> |t|)		R^2	Pr(>f)	
All	$c0$	-0.6901	0.0108	-64.0888	0.0000	*	0.7834	0.0000	*
	$c1$	0.0078	0.0017	4.7124	0.0002	*			
	$c2$	0.2618	0.0381	6.8683	0.0000	*			
	$c3$	-0.0190	0.0027	-6.9183	0.0000	*			
Buffalo	$c0$	-0.8011	0.0113	-70.9317	0.0000	*	0.8041	0.0000	*
	$c1$	0.0137	0.0017	7.8578	0.0000	*			
	$c2$	0.1832	0.0400	4.5815	0.0002	*			
	$c3$	-0.0210	0.0029	-7.2925	0.0000	*			
Detroit	$c0$	-0.6369	0.0151	-42.2245	0.0000	*	0.7967	0.0000	*
	$c1$	0.0080	0.0023	3.4500	0.0029	*			
	$c2$	0.3461	0.0534	6.4819	0.0000	*			
	$c3$	-0.0219	0.0038	-5.6943	0.0000	*			
Great Falls	$c0$	-2.0982	0.0405	-51.8416	0.0000	*	0.9334	0.0000	*
	$c1$	0.0697	0.0062	11.1804	0.0000	*			
	$c2$	0.5834	0.1433	4.0720	0.0007	*			
	$c3$	-0.0601	0.0103	-5.8322	0.0000	*			
Ogdensburg	$c0$	-1.1130	0.0244	-45.6627	0.0000	*	0.4231	0.1712	
	$c1$	0.0022	0.0038	0.5764	0.5715				
	$c2$	0.0308	0.0863	0.3575	0.7249				
	$c3$	-0.0073	0.0062	-1.1780	0.2541				
Pembina	$c0$	-2.0622	0.0399	-51.7132	0.0000	*	0.9256	0.0000	*
	$c1$	0.0743	0.0061	12.1059	0.0000	*			
	$c2$	0.7067	0.1412	5.0066	0.0000	*			
	$c3$	-0.0756	0.0102	-7.4486	0.0000	*			
Portland	$c0$	-1.9588	0.0287	-68.2183	0.0000	*	0.7104	0.0231	*
	$c1$	0.0116	0.0044	2.6337	0.0169	*			
	$c2$	-0.2911	0.1016	-2.8643	0.0103	*			
	$c3$	0.0153	0.0073	2.0967	0.0504				
Seattle	$c0$	-1.3647	0.0195	-69.9680	0.0000	*	0.7838	0.4598	
	$c1$	0.0111	0.0030	3.6902	0.0017	*			
	$c2$	-0.0677	0.0690	-0.9799	0.3401				
	$c3$	0.0026	0.0050	0.5200	0.6094				
St. Alban's	$c0$	-0.4989	0.0937	-5.3257	0.0000	*	0.5544	0.0505	
	$c1$	-0.0552	0.0144	-3.8285	0.0012	*			
	$c2$	-0.5355	0.3316	-1.6149	0.1237				
	$c3$	0.0568	0.0239	2.3829	0.0284	*			

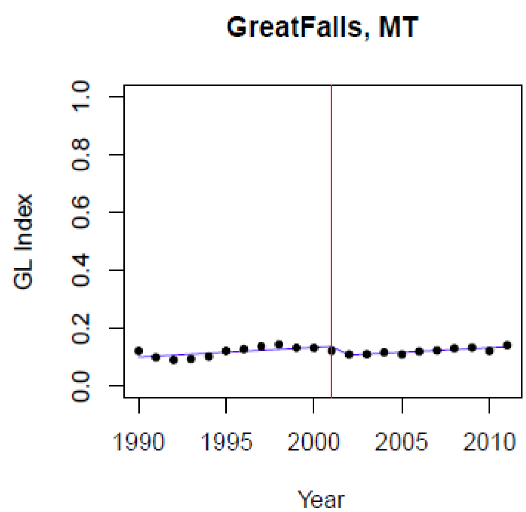
* Indicates statistical significance at .05 level.

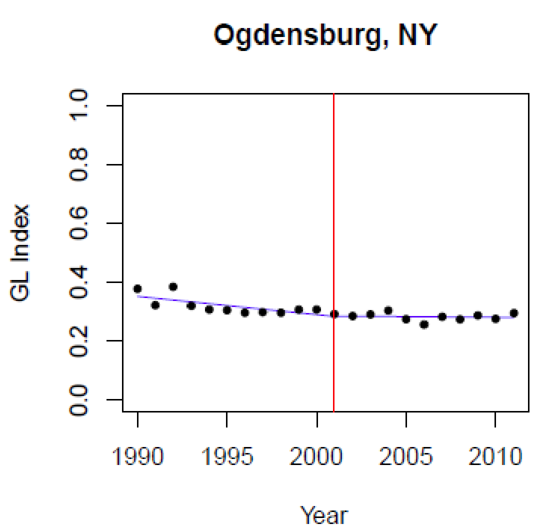
Appendix 1
Plots of GLI Values for HTS-6 Industries

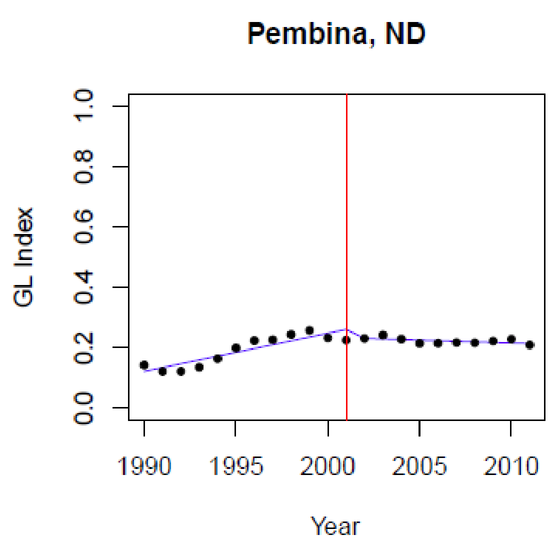


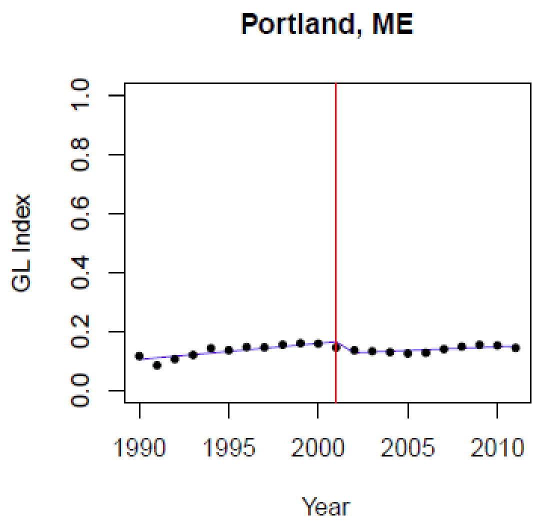


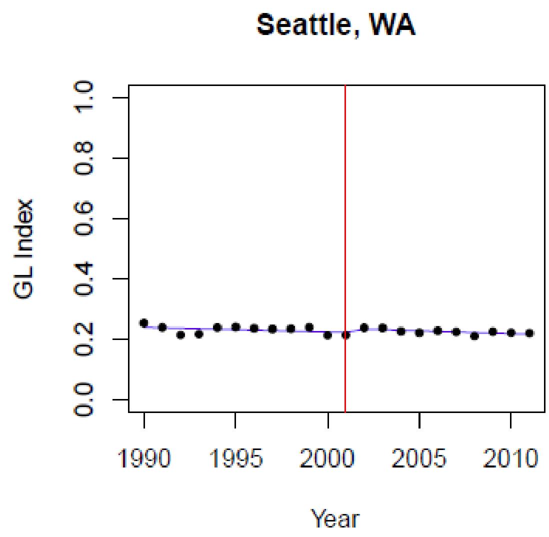


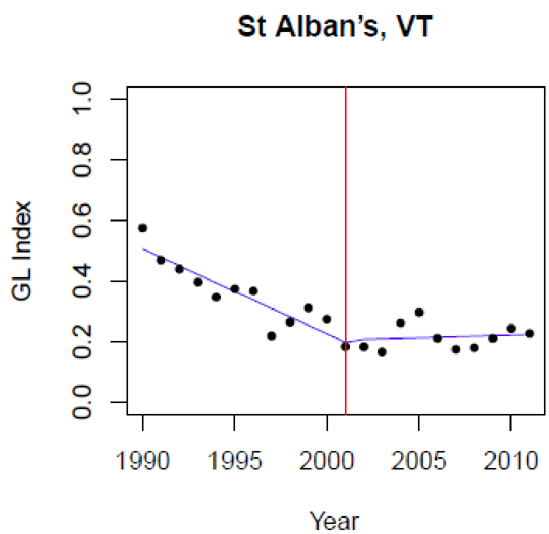







Portland, ME
GL Index
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
Year


Seattle, WA
GL Index
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
Year


St Alban's, VT
GL Index
0.0
0.2
0.4
0.6
0.8
1.0
1990
1995
2000
2005
2010
Year

Appendix 2

Logarithmic Specification: Regression Results

$$\ln(GLI/(1-GLI)) = c_0 + (c_1 \times T) + (c_2 \times D) + (c_3 \times T \times D)$$

District	Coefficient	Estimate	Std. Error	*t*-value	Pr(| > *t* |)
All	*c*0	-0.2414	0.0272	-8.8698	0.0000
	*c*1	0.0037	0.0042	0.8750	0.3931
	*c*2	0.3418	0.0963	3.5482	0.0023
	*c*3	-0.0252	0.0069	-3.6349	0.0019
Buffalo	*c*0	-0.6573	0.0934	-7.0373	0.0000
	*c*1	0.0732	0.0144	5.0872	0.0001
	*c*2	-0.0046	0.3306	-0.0138	0.9892
	*c*3	-0.0463	0.0238	-1.9463	0.0674
Detroit	*c*0	-0.2557	0.0489	-5.2325	0.0001
	*c*1	-0.0044	0.0075	-0.5887	0.5634
	*c*2	0.7925	0.1730	4.5816	0.0002
	*c*3	-0.0313	0.0124	-2.5152	0.0216
Great Falls	*c*0	-2.1892	0.0581	-37.6783	0.0000
	*c*1	0.0325	0.0089	3.6363	0.0019
	*c*2	-0.2618	0.2057	-1.2727	0.2193
	*c*3	-0.0038	0.0148	-0.2555	0.8013
Ogdensburg	*c*0	-0.6087	0.0477	-12.7524	0.0000
	*c*1	-0.0281	0.0074	-3.8293	0.0012
	*c*2	-0.2854	0.1690	-1.6893	0.1084
	*c*3	0.0260	0.0122	2.1364	0.0466
Pembina	*c*0	-1.9464	0.0684	-28.4524	0.0000
	*c*1	0.0859	0.0105	8.1534	0.0000
	*c*2	0.8751	0.2422	3.6136	0.0020
	*c*3	-0.0968	0.0174	-5.5548	0.0000
Portland	*c*0	-2.1324	0.0577	-36.9837	0.0000
	*c*1	0.0494	0.0089	5.5582	0.0000
	*c*2	-0.0278	0.2041	-0.1363	0.8931
	*c*3	-0.0283	0.0147	-1.9285	0.0697
Seattle	*c*0	-1.1499	0.0319	-36.0631	0.0000
	*c*1	-0.0083	0.0049	-1.6968	0.1070
	*c*2	0.0985	0.1129	0.8726	0.3944
	*c*3	-0.0024	0.0081	-0.2931	0.7728
St. Alban's	*c*0	0.0546	0.1295	0.4220	0.6780
	*c*1	-0.1265	0.0199	-6.3471	0.0000
	*c*2	-1.5742	0.4582	-3.4352	0.0030
	*c*3	0.1396	0.0330	4.2346	0.0005

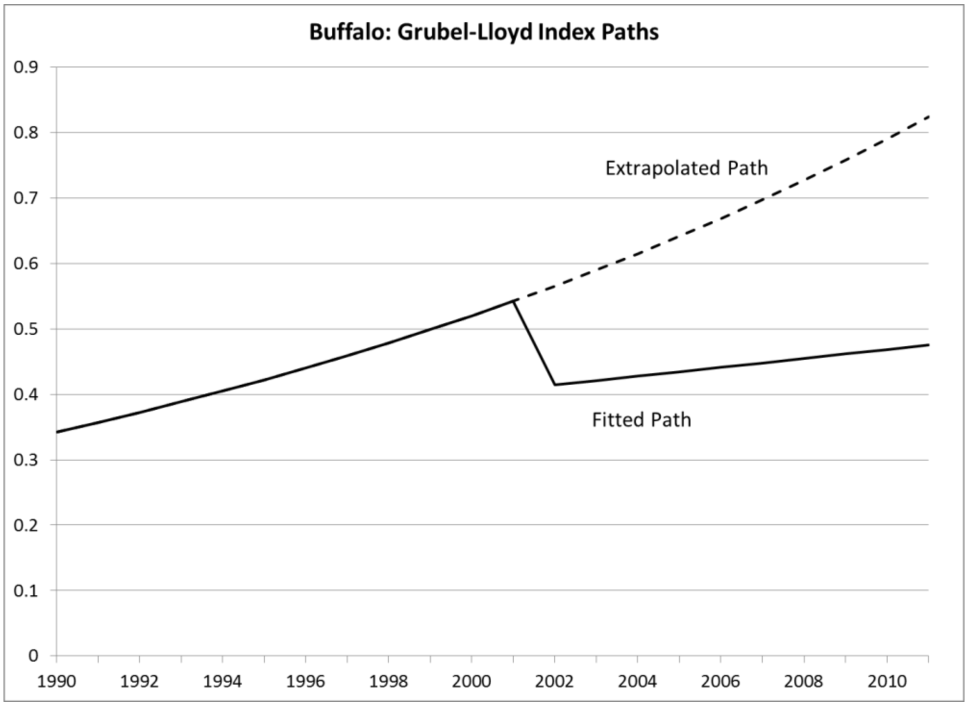
Chow Test

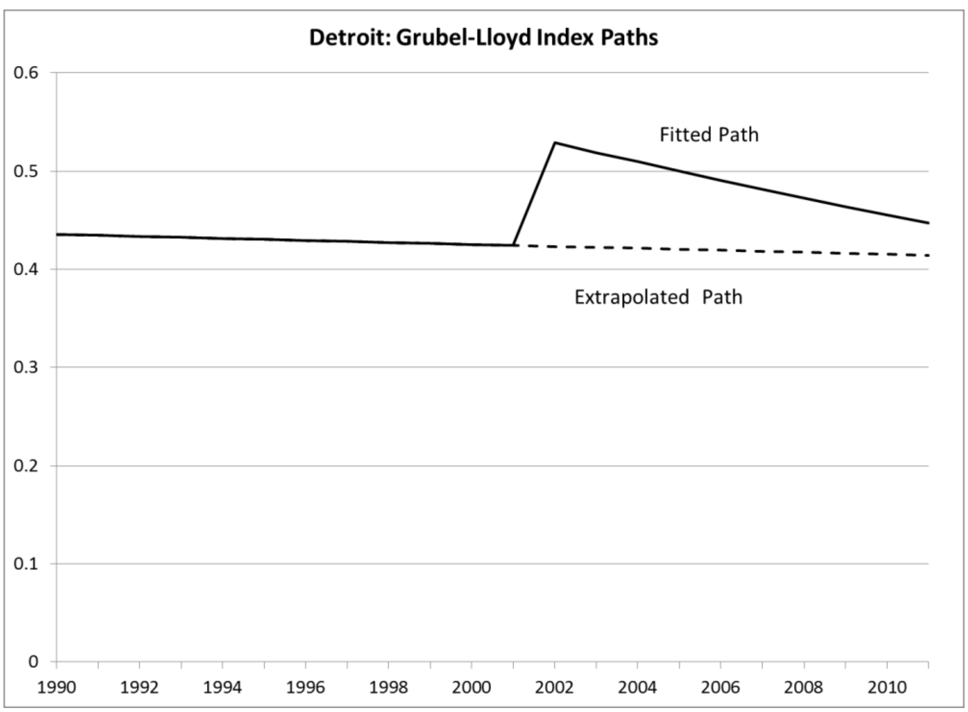
$H_0 : c_2 = c_3 = 0$

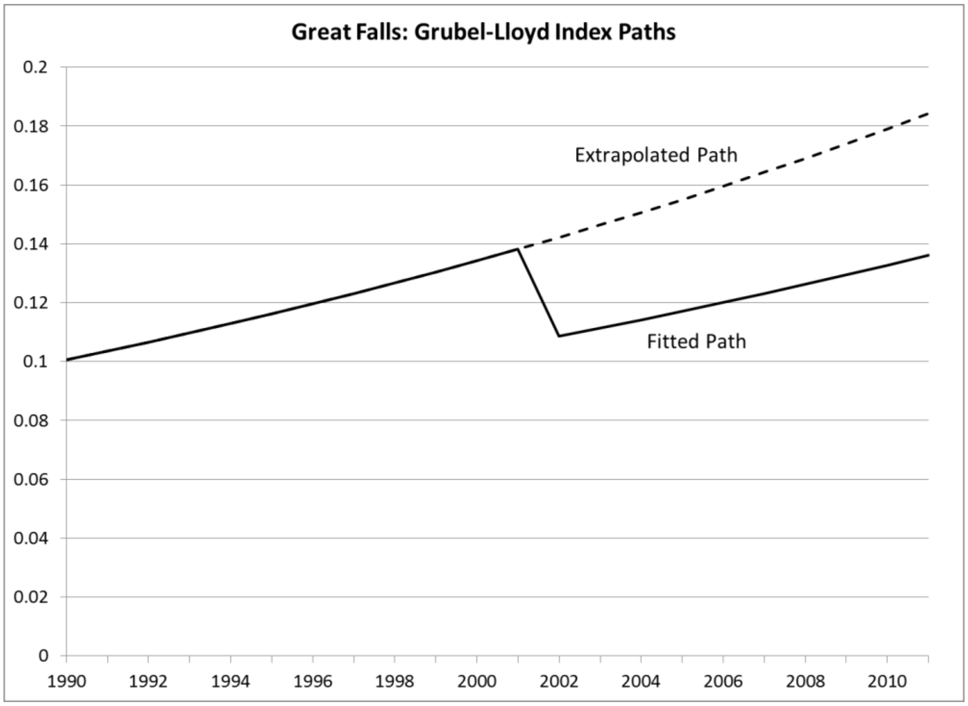
District	**Base** *R2*	**Full** *R2*	*f* **-val**	*p*-**val**	
All	0.1309	0.5055	6.8171	0.0063	*
Buffalo	0.1832	0.6099	9.8448	0.0013	*
Detroit	0.2135	0.7281	17.0310	0.0001	*
Great Falls	0.2142	0.5229	5.8216	0.0112	*
Ogdensburg	0.5637	0.6560	2.4151	0.1177	
Pembina	0.4280	0.8240	20.2497	0.0000	*
Portland	0.2562	0.6619	10.8025	0.0008	*
Seattle	0.2093	0.2881	0.9968	0.3886	
St. Alban's	0.6365	0.8213	9.3071	0.0017	*

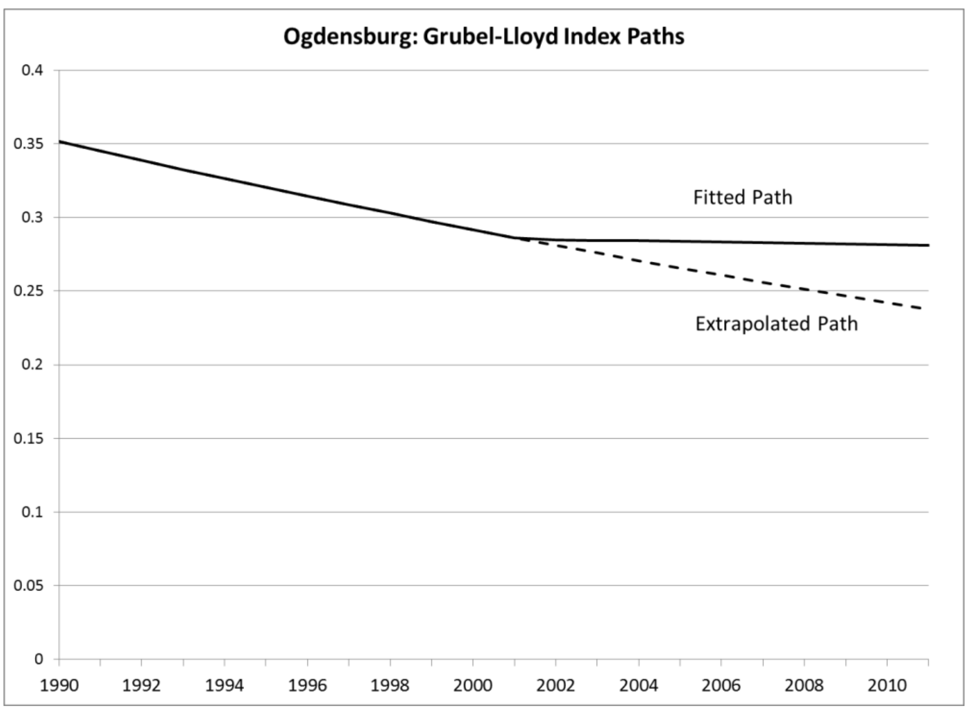
Appendix 3

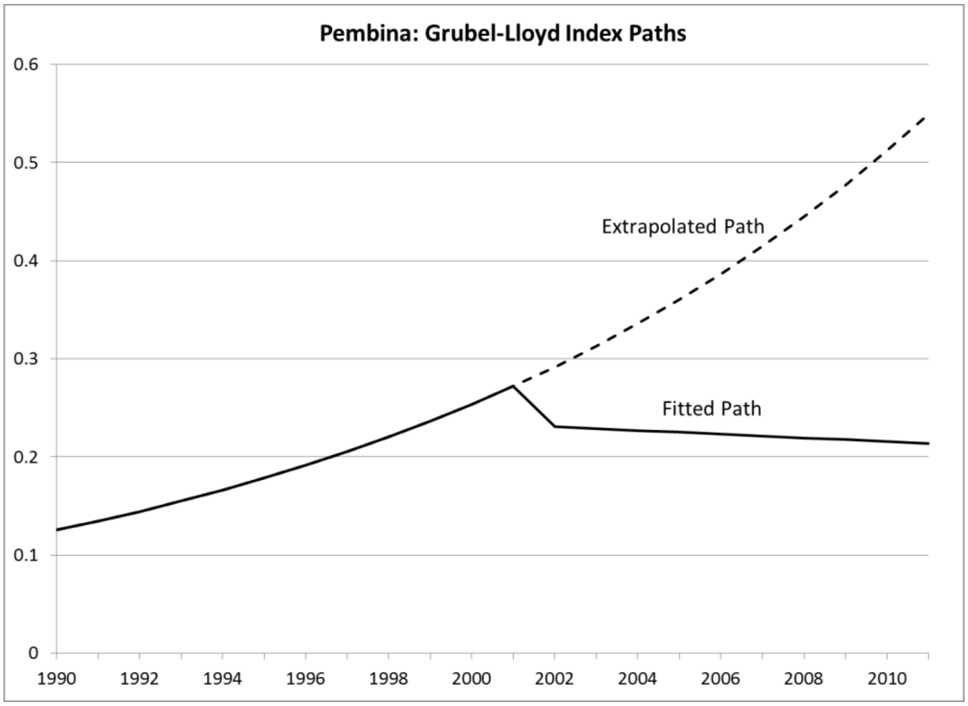
Extrapolated and Fitted Grubel-Lloyd Index Paths

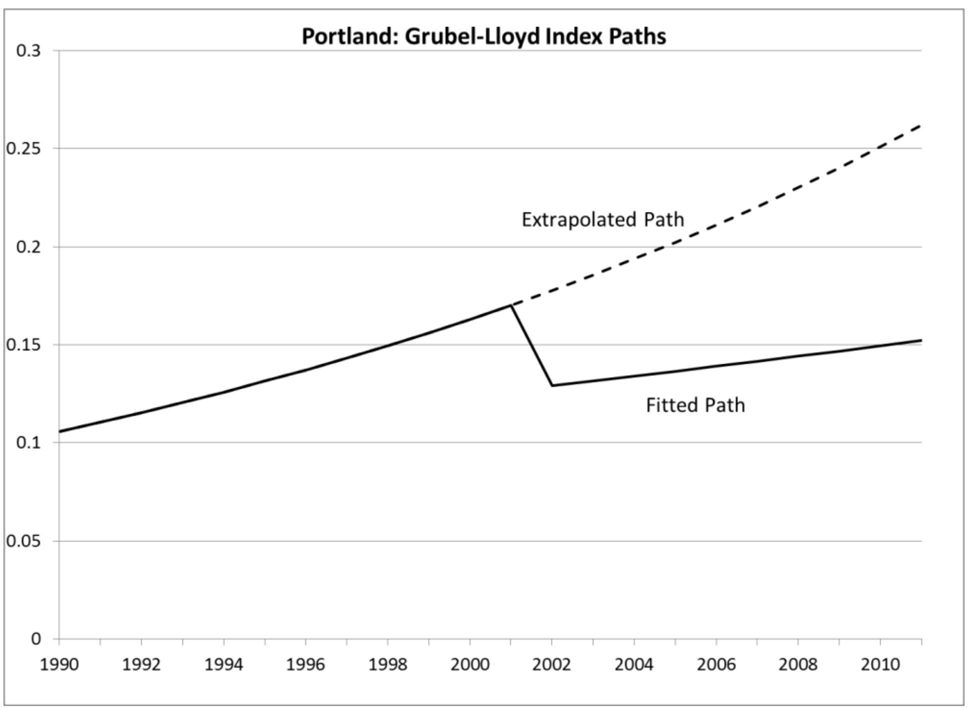


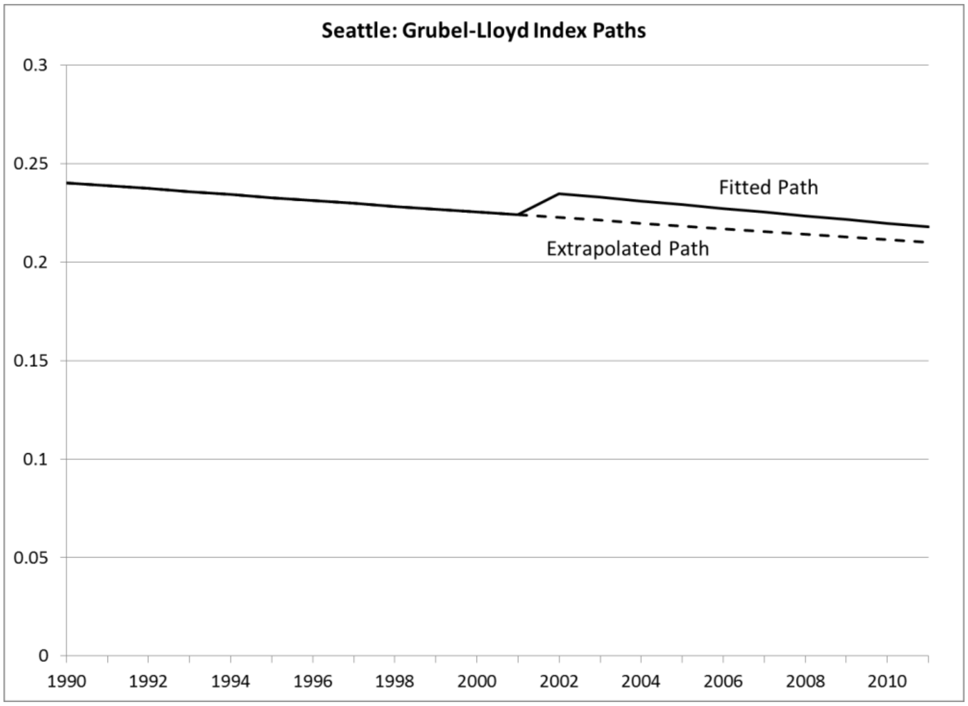


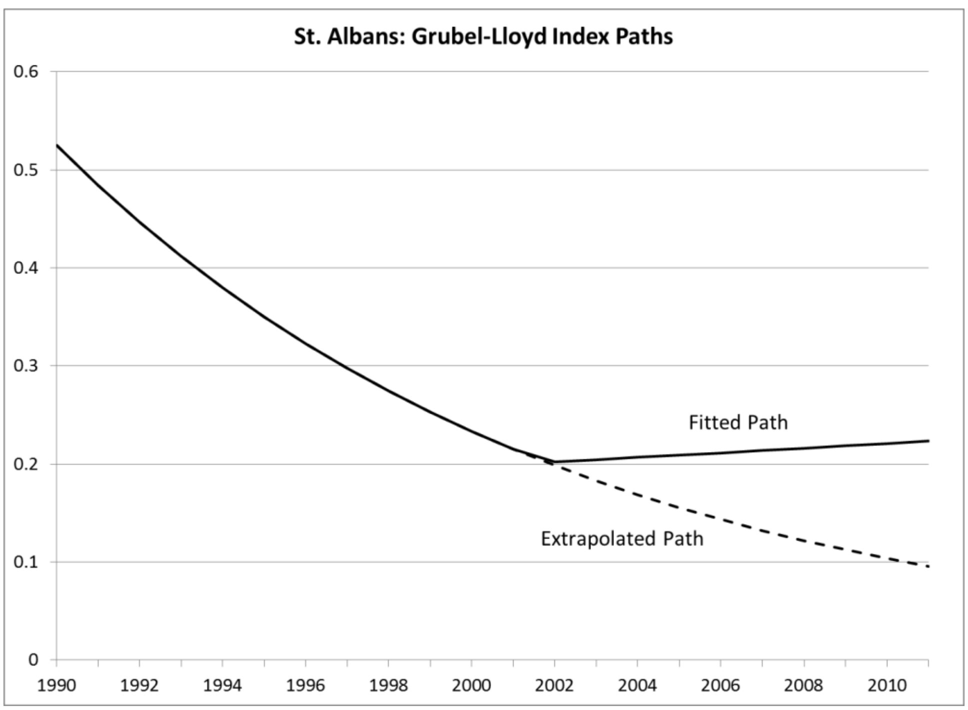

Great Falls: Grubel-Lloyd Index Paths
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

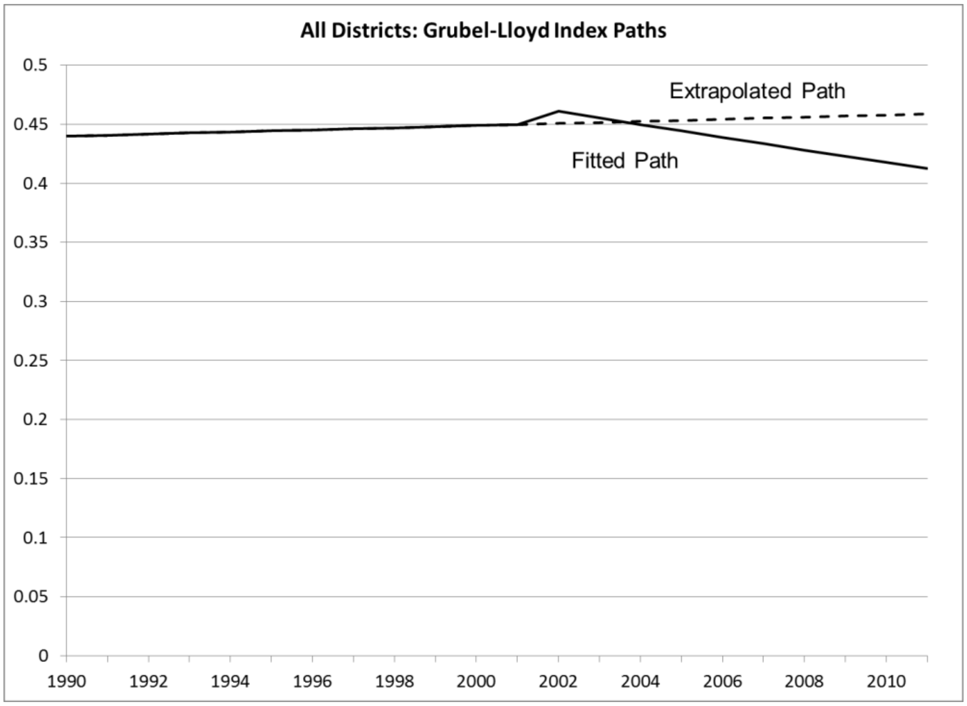

Ogdensburg: Grubel-Lloyd Index Paths
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path


Pembina: Grubel-Lloyd Index Paths
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path


Portland: Grubel-Lloyd Index Paths
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

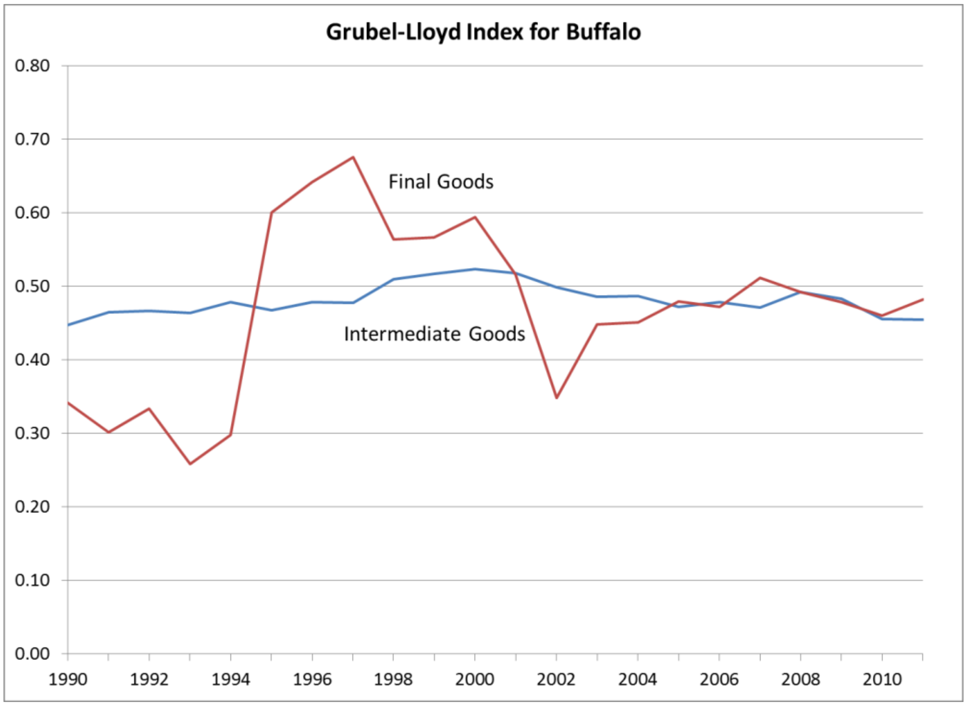

Seattle: Grubel-Lloyd Index Paths
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path

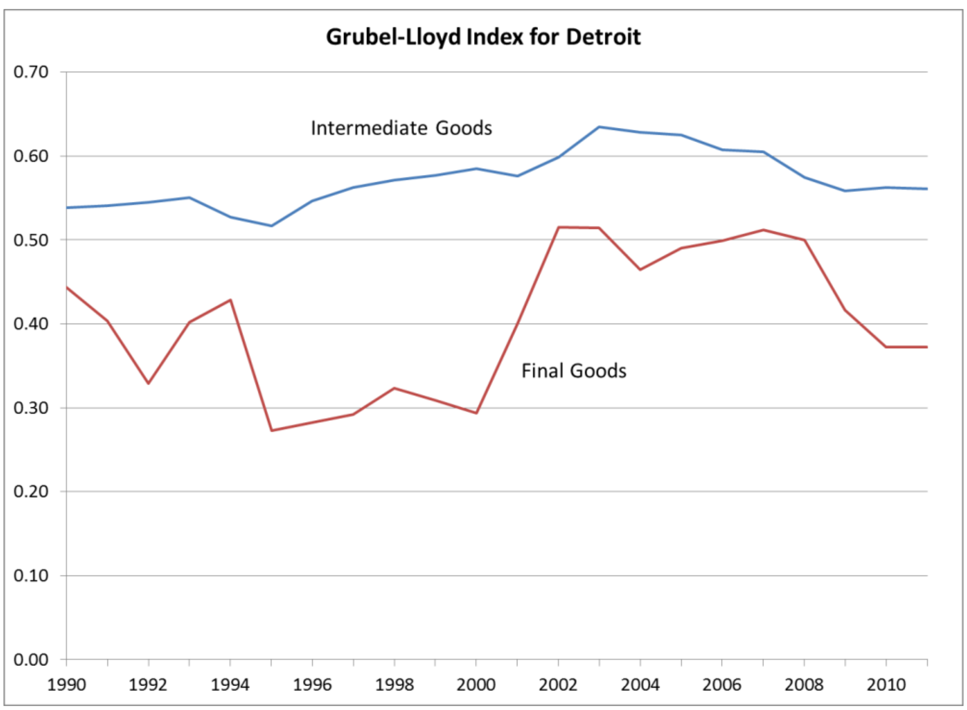

St. Albans: Grubel-Lloyd Index Paths
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path

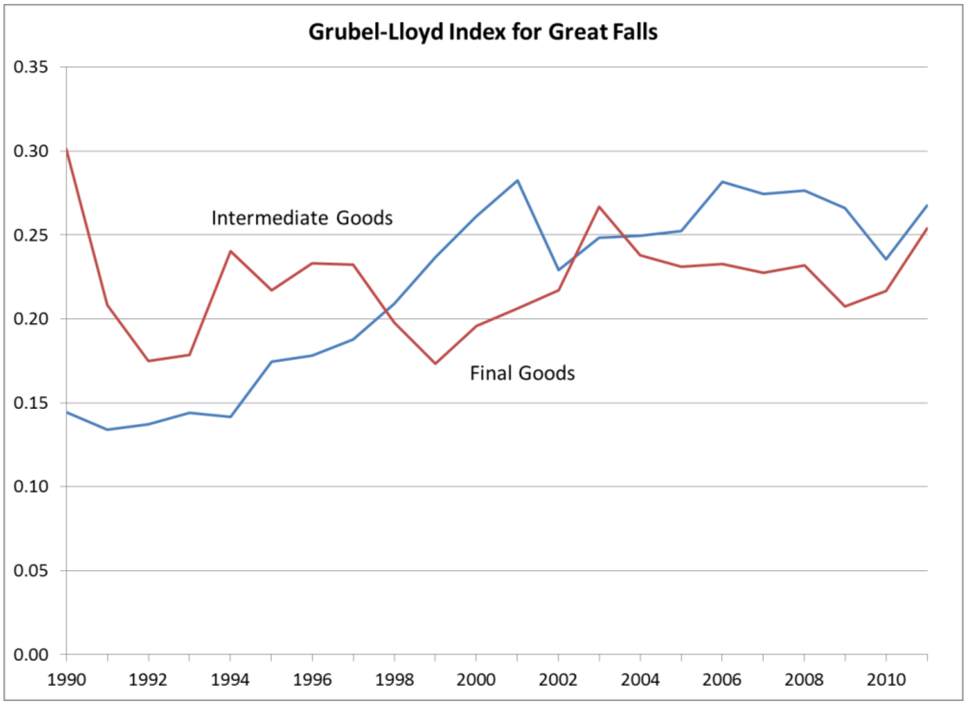

All Districts: Grubel-Lloyd Index Paths
Extrapolated Path
Fitted Path
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

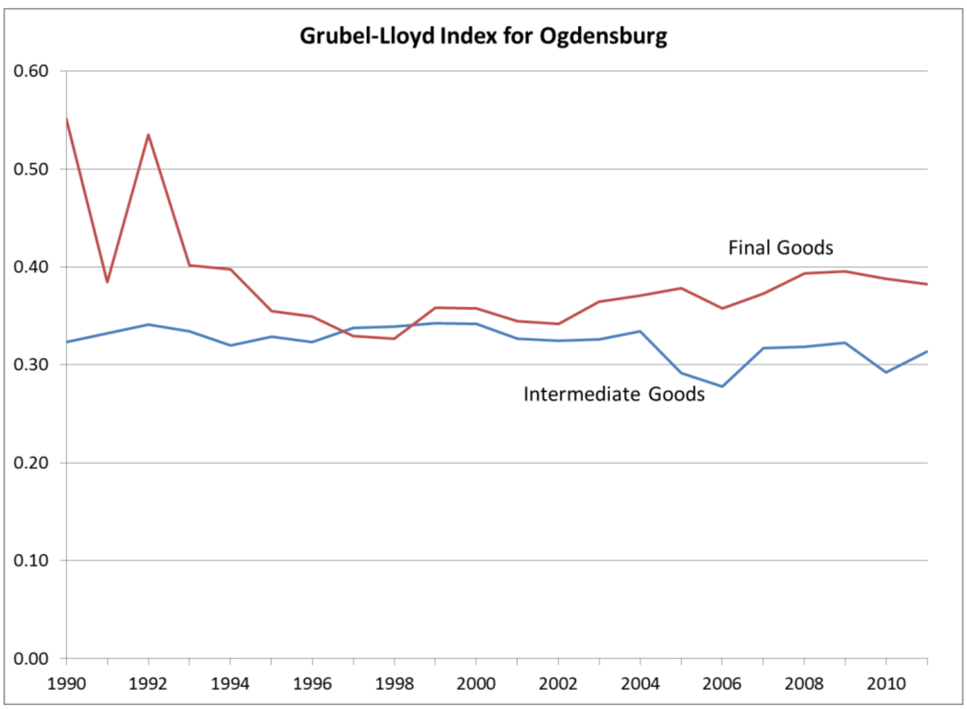
Appendix 4

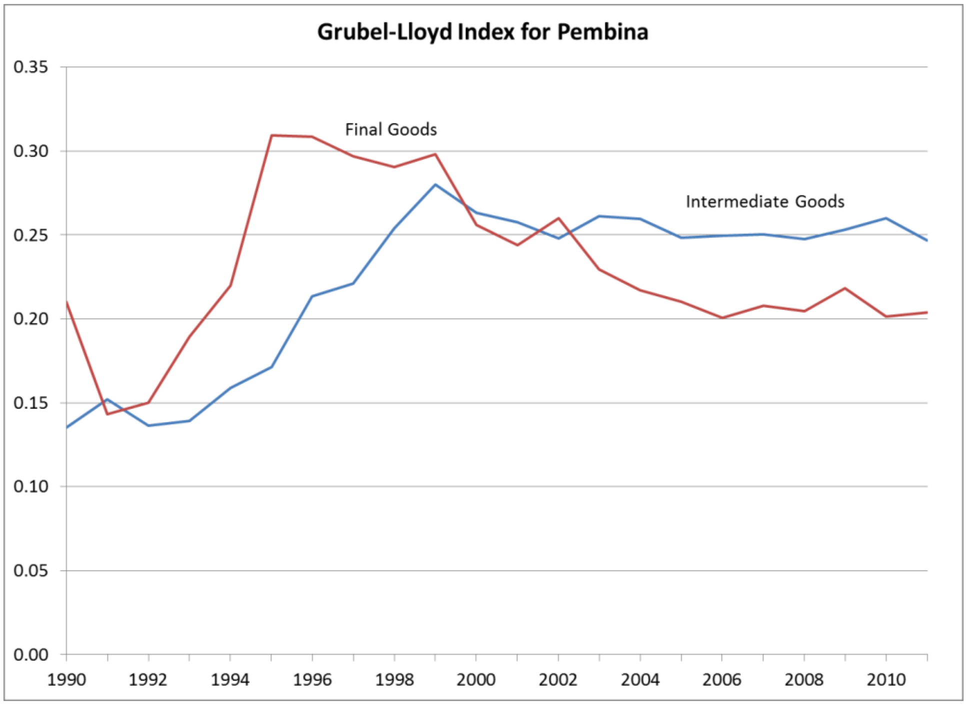
District-Level Grubel-Lloyd Index Values for Final and Intermediate Goods Trade

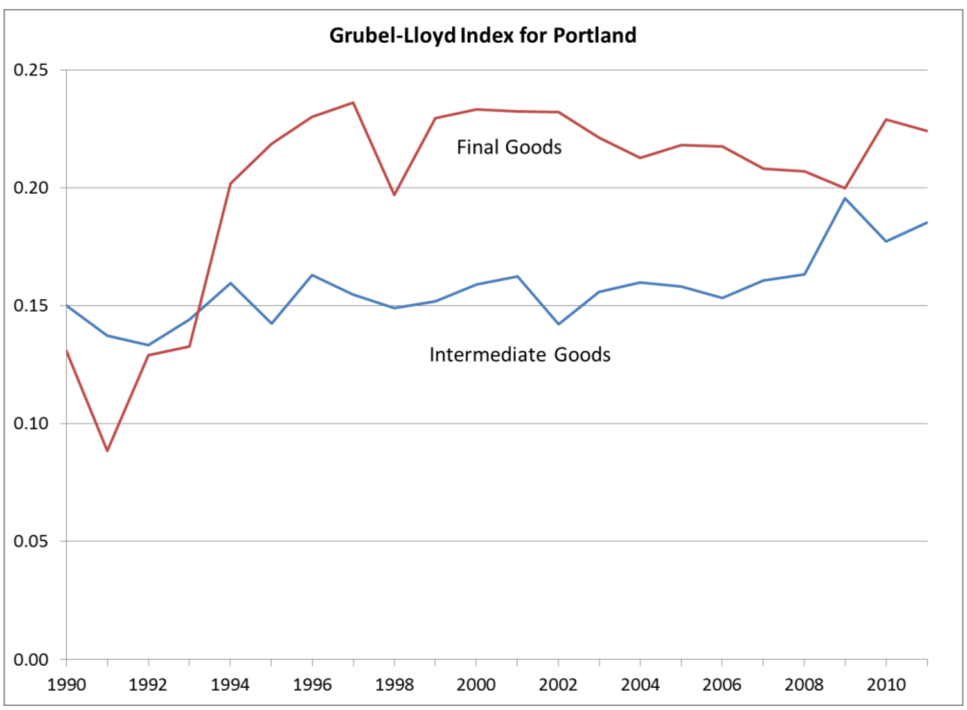


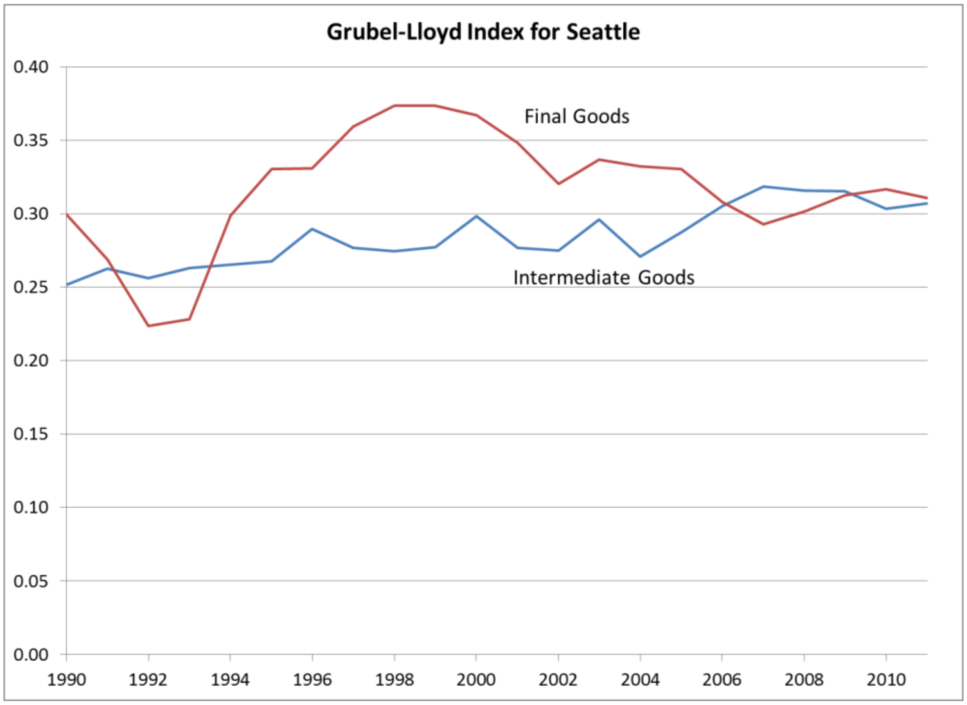


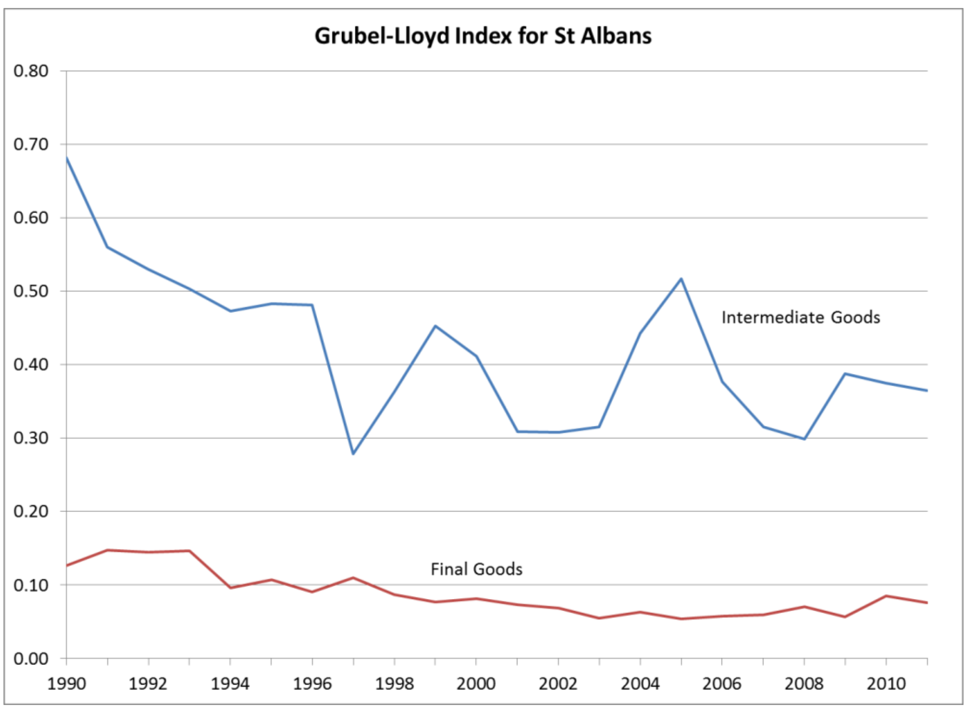

Grubel-Lloyd Index for Great Falls
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Intermediate Goods
Final Goods

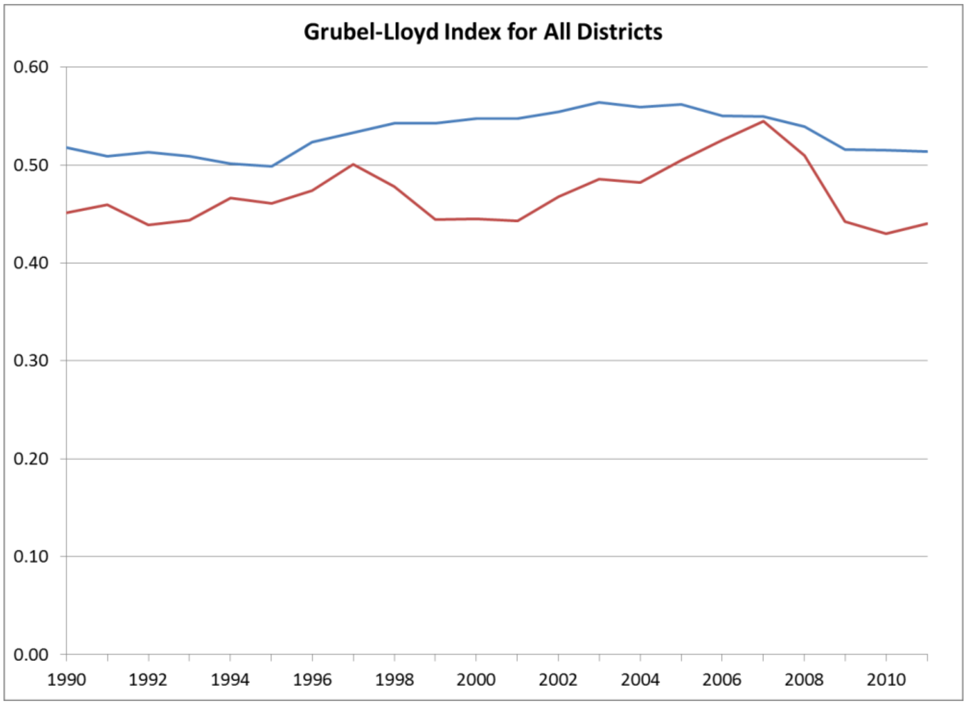

Grubel-Lloyd Index for Ogdensburg
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Final Goods
Intermediate Goods


Grubel-Lloyd Index for Pembina
Final Goods
Intermediate Goods
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


Grubel-Lloyd Index for Portland
Final Goods
Intermediate Goods
0.25
0.20
0.15
0.10
0.05
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

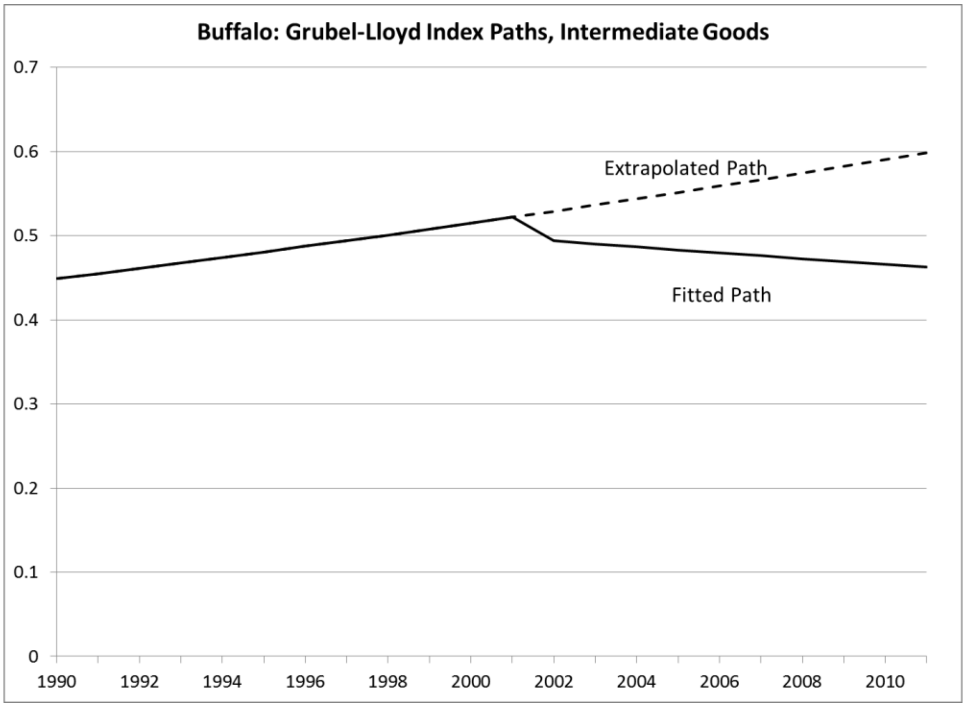

Grubel-Lloyd Index for Seattle
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Final Goods
Intermediate Goods

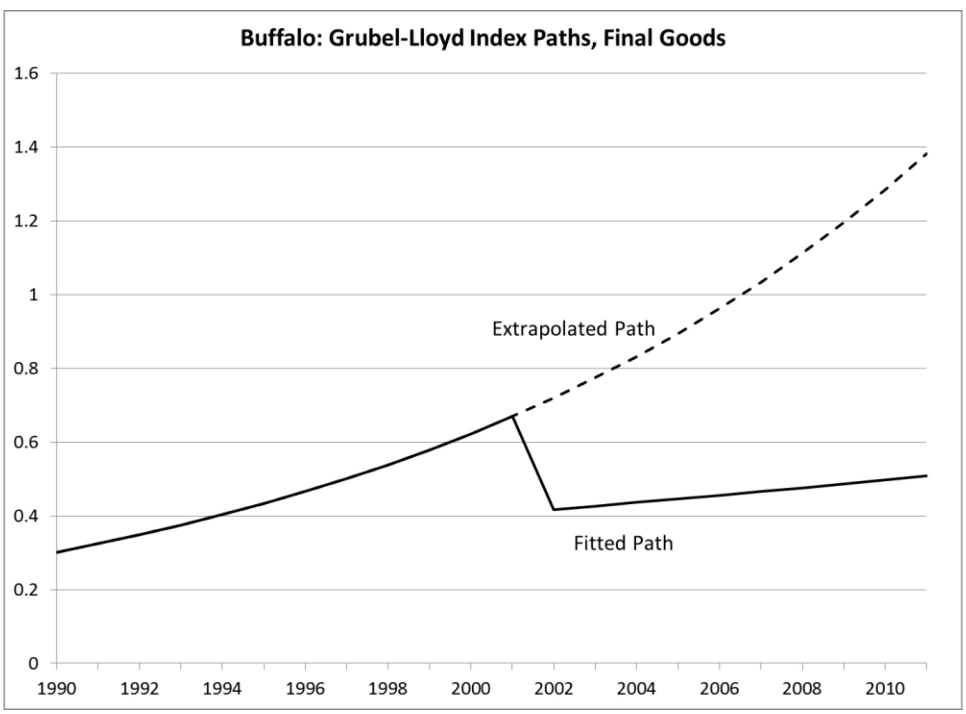

Grubel-Lloyd Index for St Albans
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Intermediate Goods
Final Goods

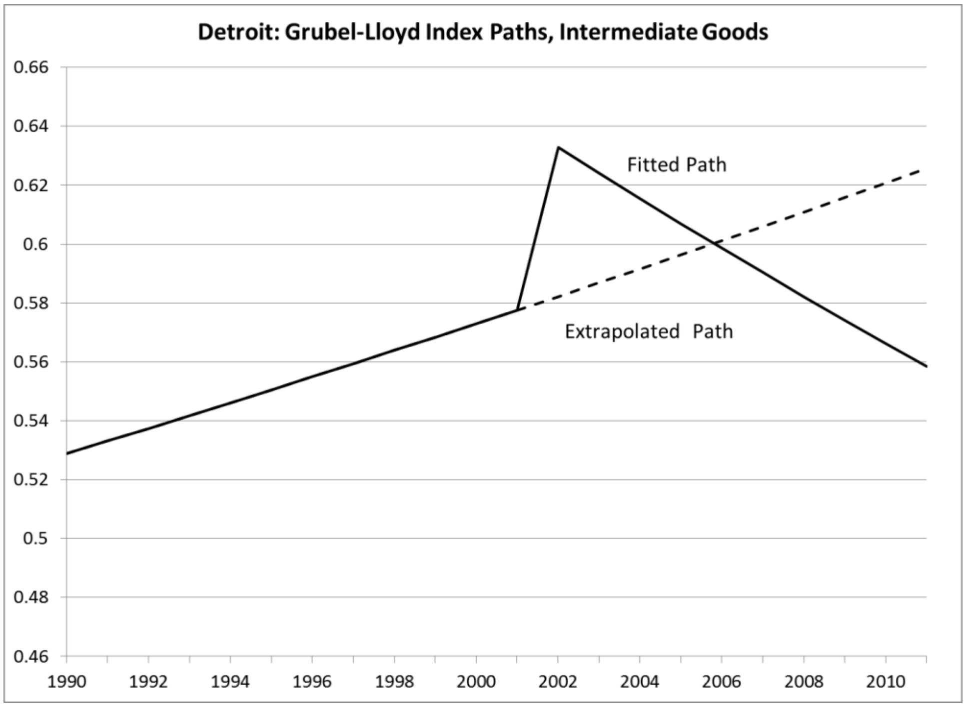

Grubel-Lloyd Index for All Districts
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

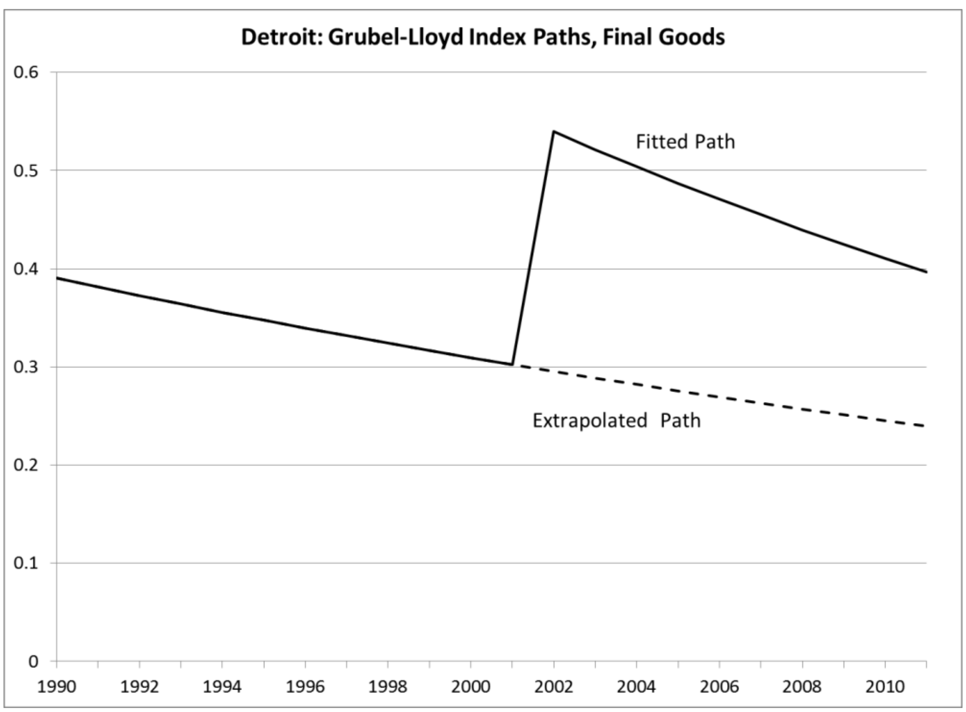
Appendix 5

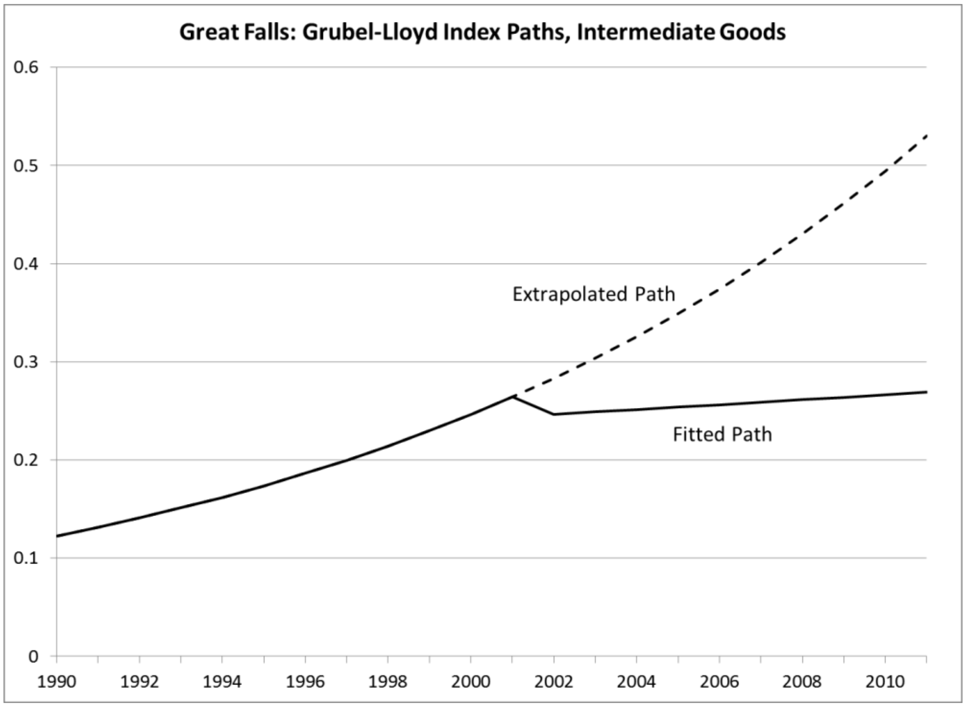
Extrapolated and Fitted Grubel-Lloyd Index Paths for Final and Intermediate Goods

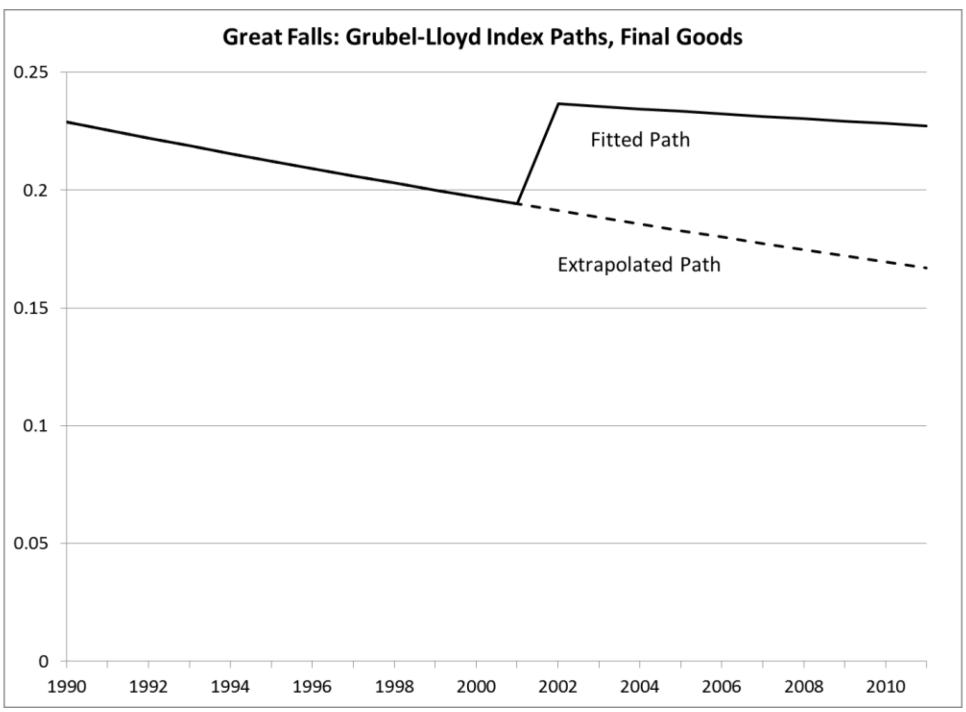


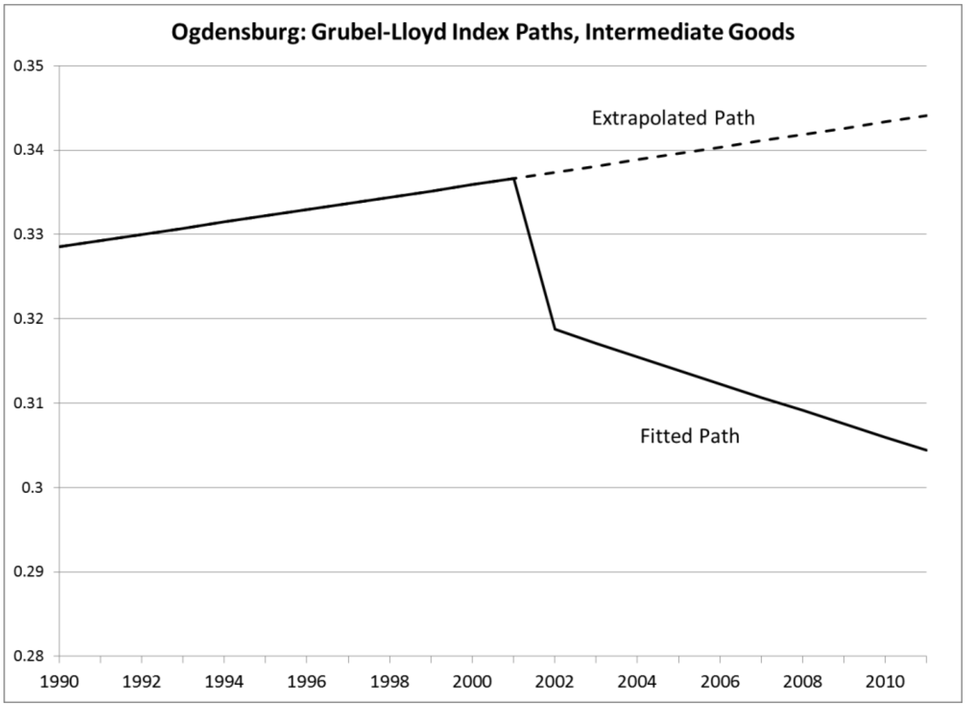


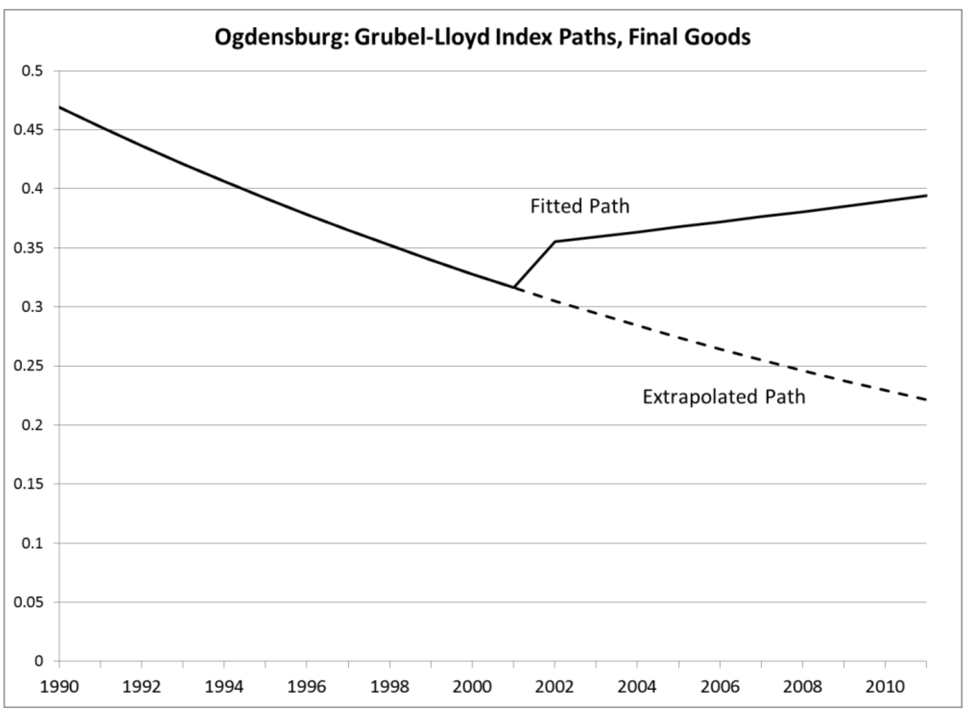

Detroit: Grubel-Lloyd Index Paths, Intermediate Goods
Fitted Path
Extrapolated Path
0.66
0.64
0.62
0.6
0.58
0.56
0.54
0.52
0.5
0.48
0.46
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

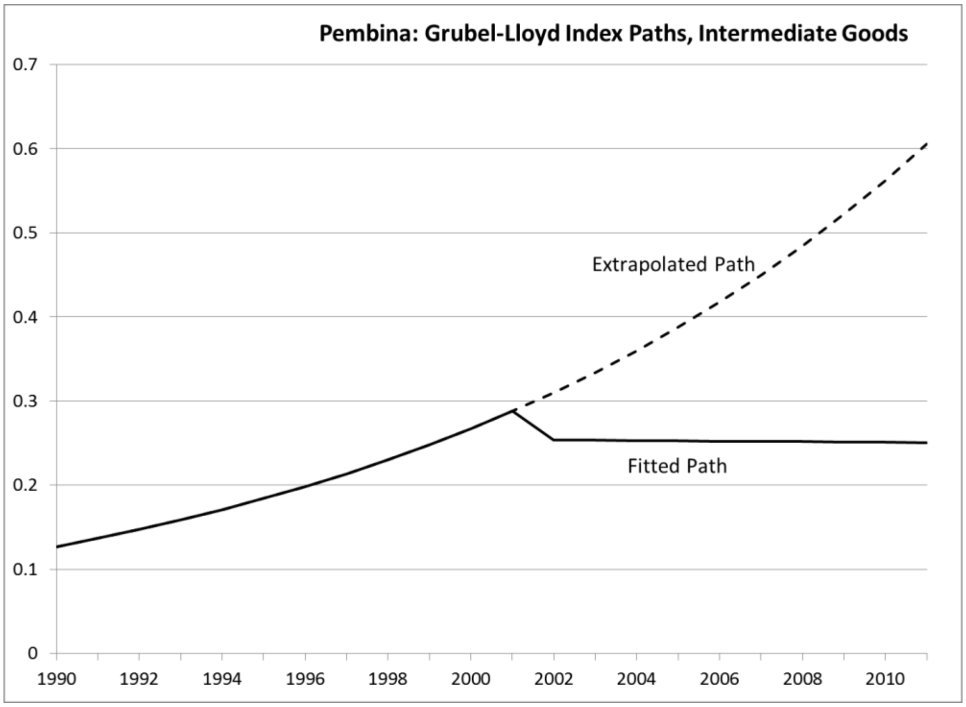

Detroit: Grubel-Lloyd Index Paths, Final Goods
Fitted Path
Extrapolated Path
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

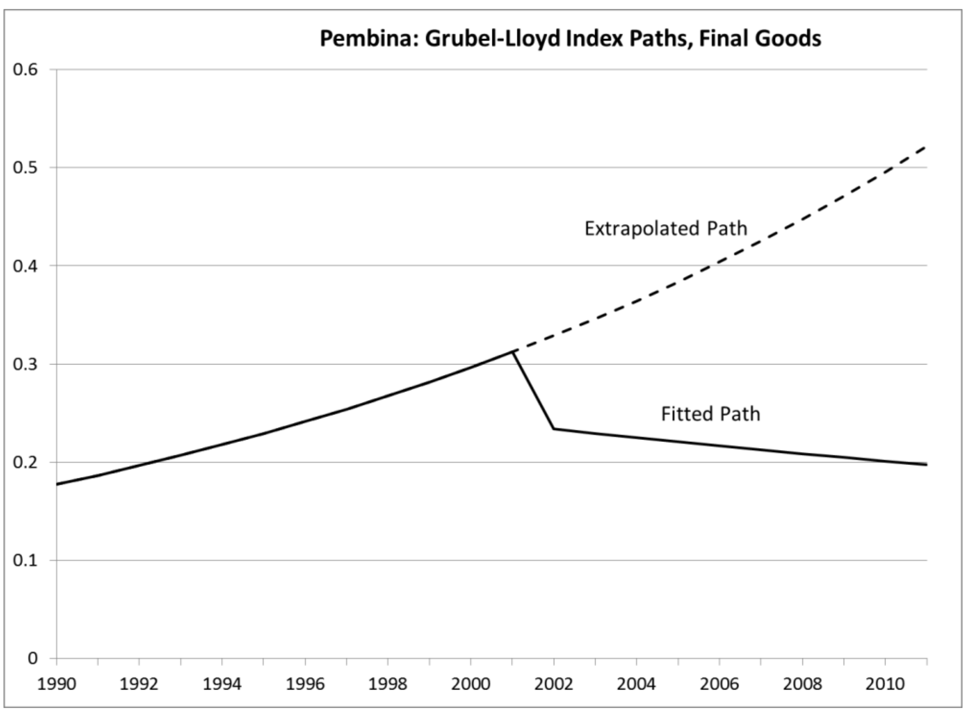

Great Falls: Grubel-Lloyd Index Paths, Intermediate Goods
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

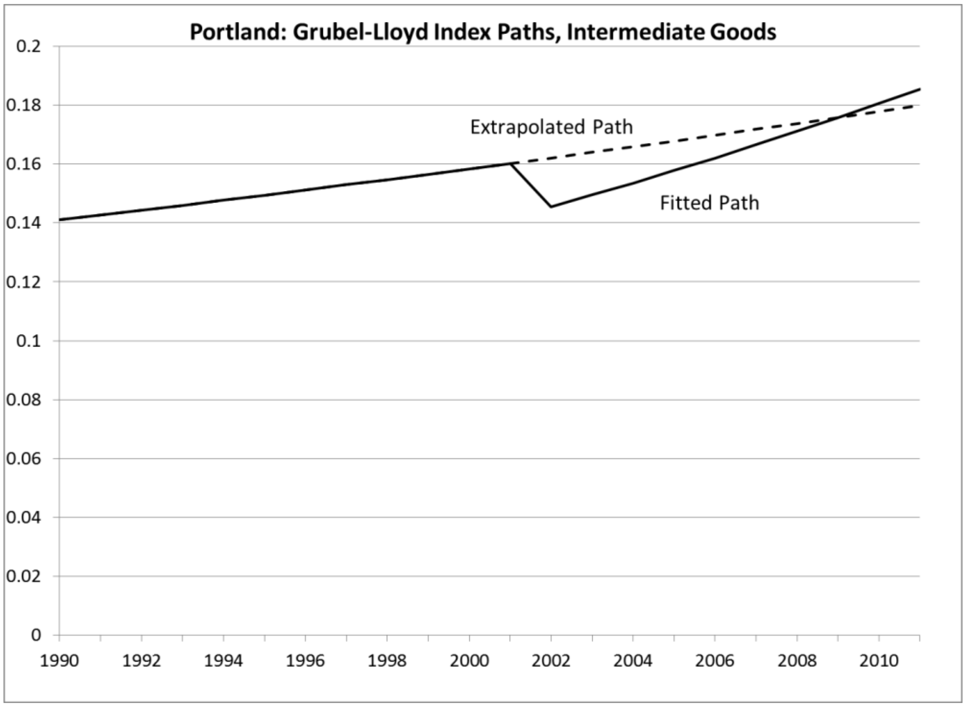

Great Falls: Grubel-Lloyd Index Paths, Final Goods
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path

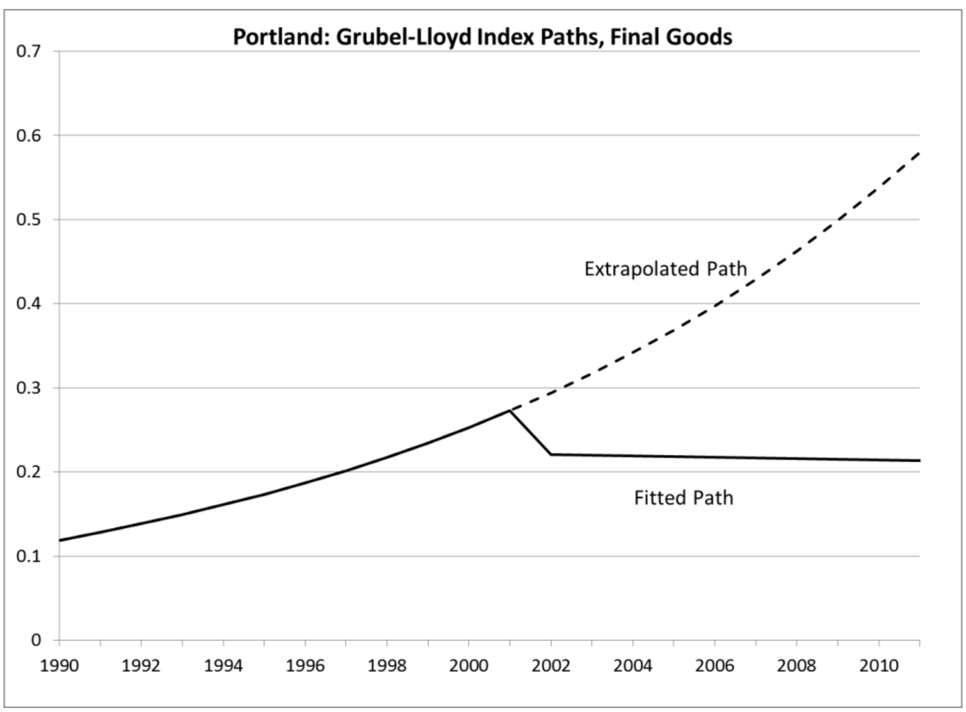

Ogdensburg: Grubel-Lloyd Index Paths, Intermediate Goods
Extrapolated Path
Fitted Path
0.35
0.34
0.33
0.32
0.31
0.3
0.29
0.28
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

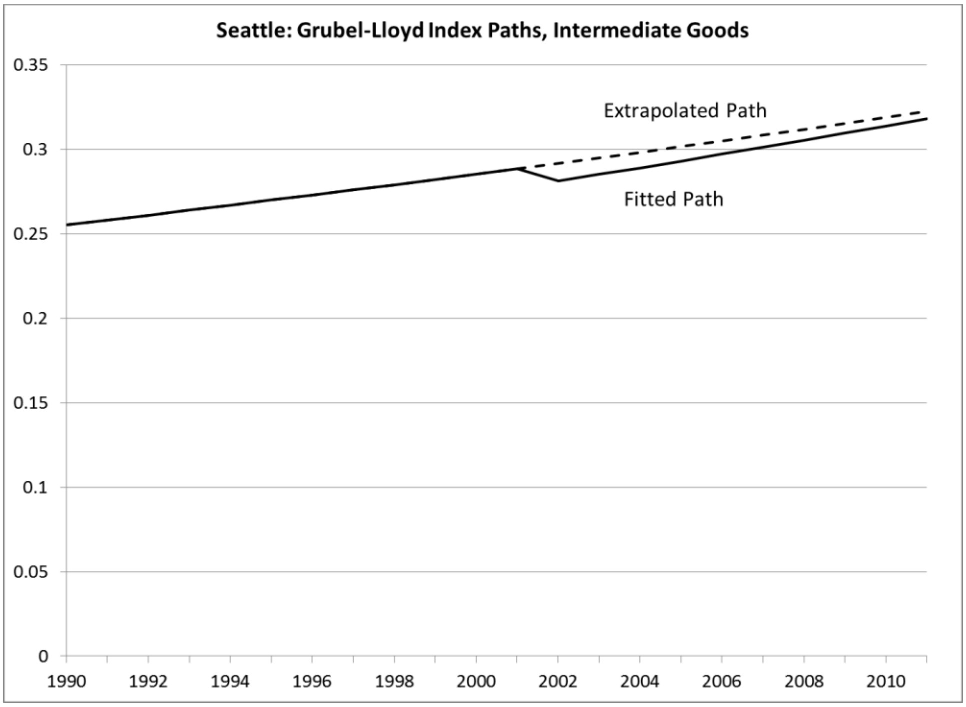

Ogdensburg: Grubel-Lloyd Index Paths, Final Goods
Fitted Path
Extrapolated Path
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

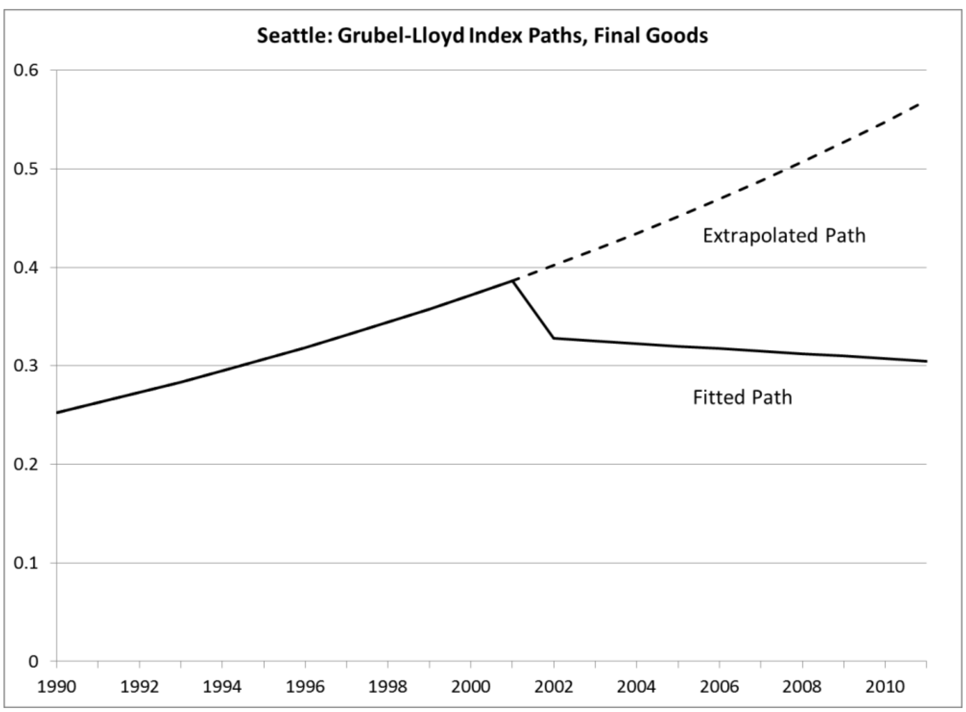

Pembina: Grubel-Lloyd Index Paths, Intermediate Goods
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

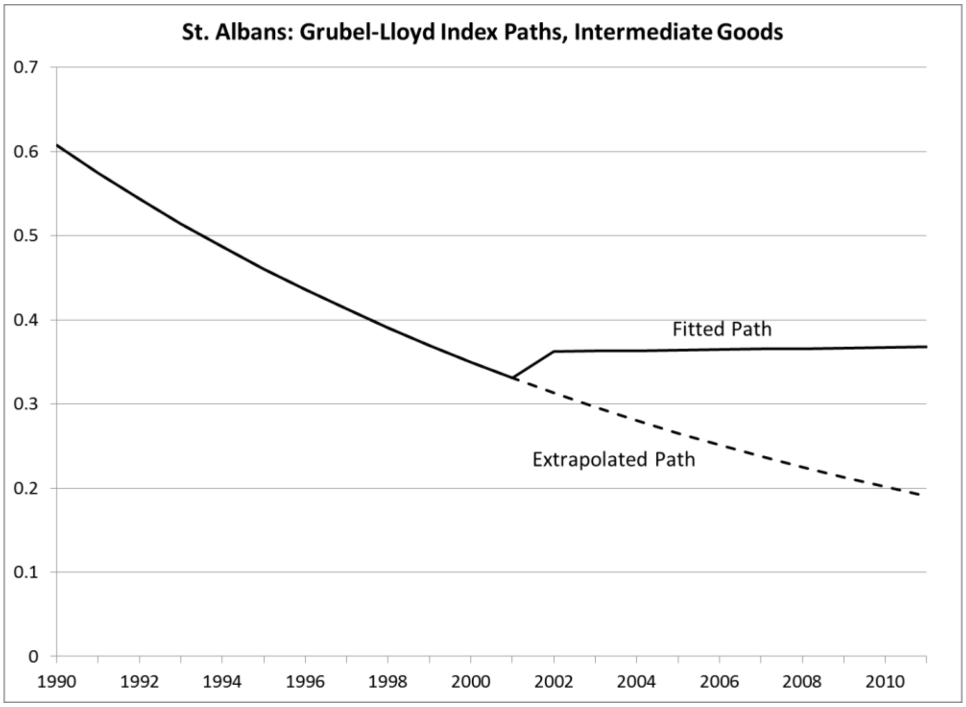

Pembina: Grubel-Lloyd Index Paths, Final Goods
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

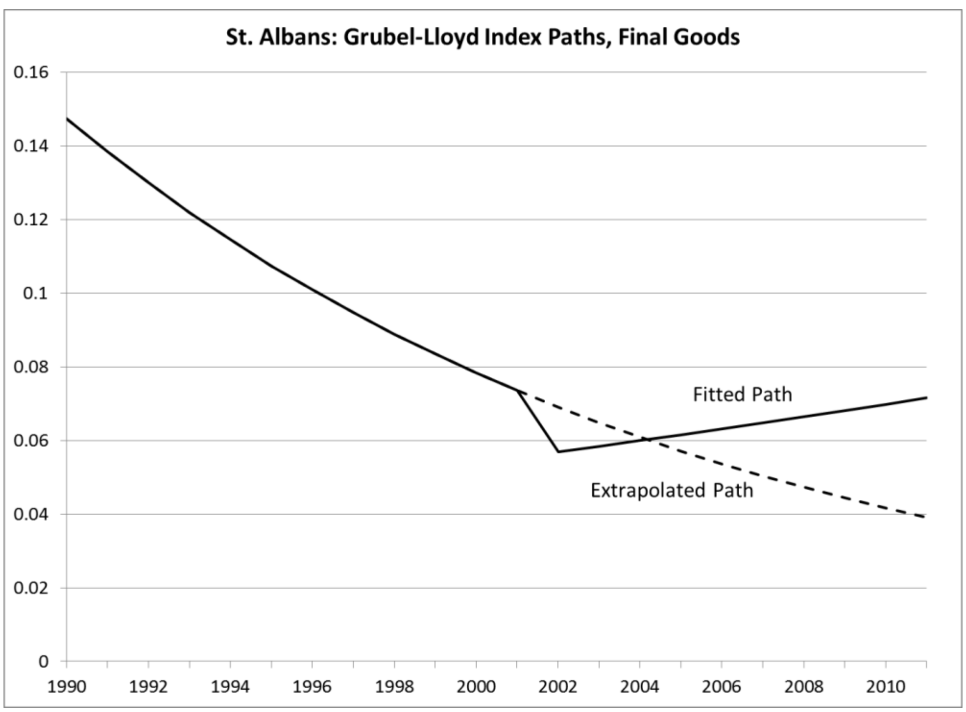

Portland: Grubel-Lloyd Index Paths, Intermediate Goods
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

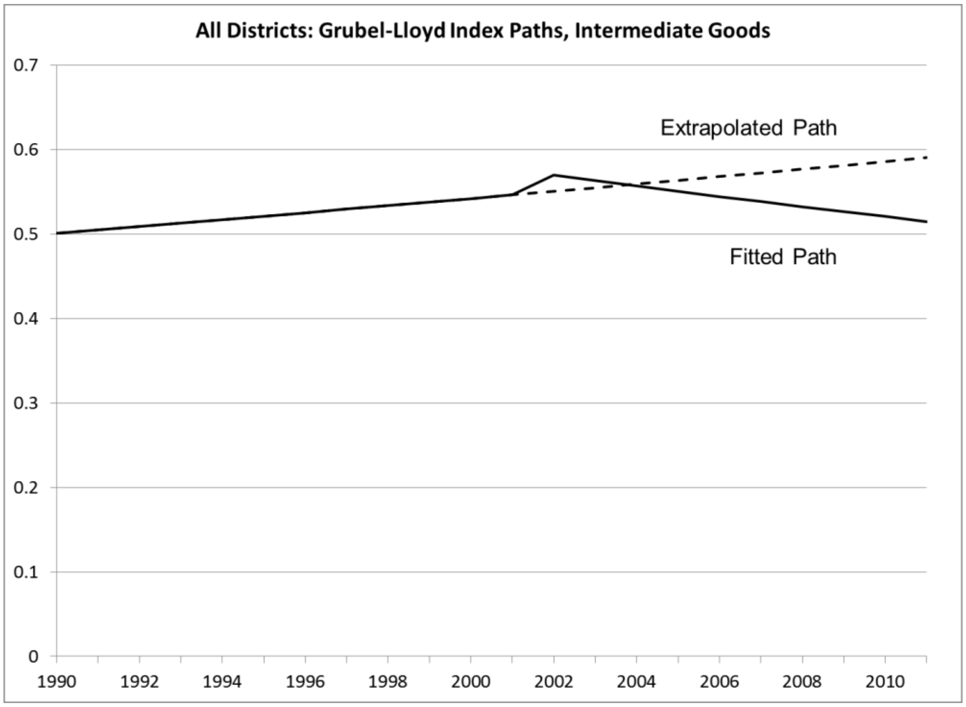

Portland: Grubel-Lloyd Index Paths, Final Goods
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path

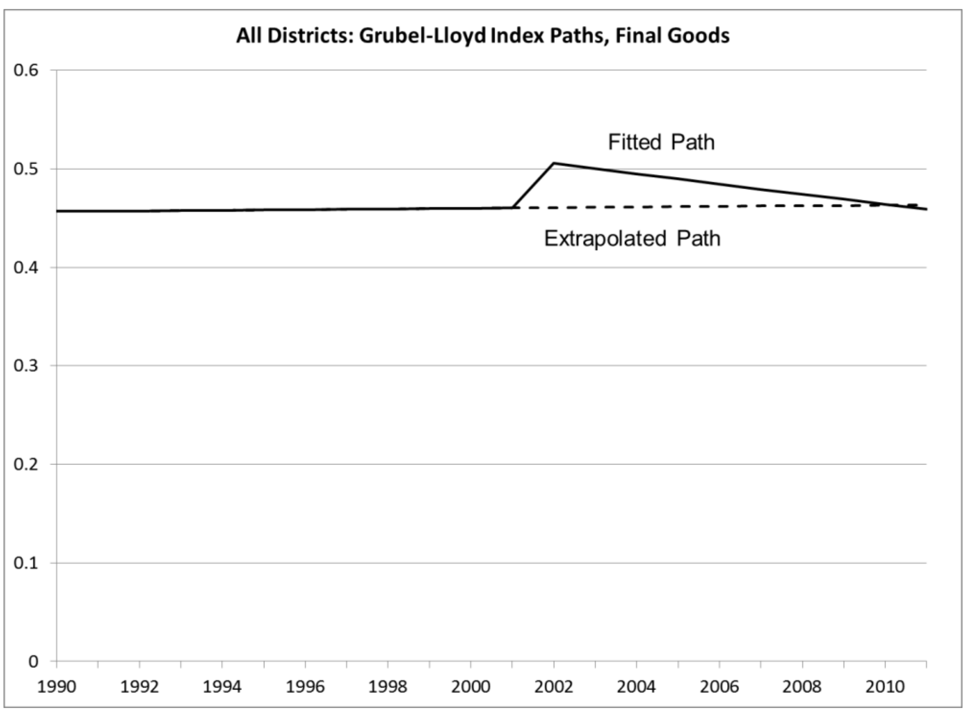

Seattle: Grubel-Lloyd Index Paths, Intermediate Goods
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path


Seattle: Grubel-Lloyd Index Paths, Final Goods
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Extrapolated Path
Fitted Path


St. Albans: Grubel-Lloyd Index Paths, Intermediate Goods
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path


St. Albans: Grubel-Lloyd Index Paths, Final Goods
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Fitted Path
Extrapolated Path


All Districts: Grubel-Lloyd Index Paths, Intermediate Goods
Extrapolated Path
Fitted Path
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


All Districts: Grubel-Lloyd Index Paths, Final Goods
Fitted Path
Extrapolated Path
0.6
0.5
0.4
0.3
0.2
0.1
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010