The Database *Pesquisa Industrial Anual* 1986-2001: A Detective's Report*

Marc-Andreas Muendler†
University of California, San Diego

November 16, 2003

Abstract

This report summarizes characteristics of the Brazilian *Pesquisa Industrial Anual*, a survey of Brazilian manufacturing firms and plants conducted annually by the Brazilian census bureau *IBGE* between 1986 and 1990, and from 1992 to the present. Paying attention mostly to firms, for which better data are available than for plants, the report discusses three major concerns. First, it documents the longitudinal relations between firms such as entry, creation, exit, and absorption by other firms. Second, it proposes ways to link economic variables over time, correcting for changes in surveying methods. Third, this report recommends ways to deflate the economic variables in *PIA*.

*I owe special thanks to Wasmália Bivar, Alexandre Brandão, Sílvio Sales and the team at *IBGE*'s *Departamento de Indústria*, Rio de Janeiro, for their support and patience in providing access to the data. I am indebted to Gustavo Gonzaga and Humberto Moreira at PUC Rio de Janeiro who opened doors for me and made this project possible. I am thankful to Dieter Simons of Siemens S.A., São Paulo, for introducing me to the practice of accounting in Brazil, and to Adriana Schor at Fundação Getúlio Vargas, São Paulo for many insightful discussions. I gratefully acknowledge financial support from the Social Science Research Council, New York, and the American Council of Learned Societies with an International Predissertation Fellowship (funded by the Ford Foundation).

†muendler@ucsd.edu (*www.econ.ucsd.edu/muendler*)

Many economic topics are being reexamined with panel data at the firm or plant level. Brazil is one of the few developing countries that has surveyed and continues to survey its manufacturing sector systematically.[1] The present report aims at introducing the Brazilian *Pesquisa Industrial Anual* (*PIA*) to the research community as a further database with several unique features that may allow analyses not carried out so far. As such, this report summarizes results of the unglamorous but necessary data construction and cleaning efforts.

The following section 1 describes the sampling method and the main types of variables in *Pesquisa Industrial Anual PIA*, Brazil's annual manufacturing survey. Section 2 documents an analysis of the longitudinal relations between firms in this database. *PIA* traces in detail firm entries, exits, phases of suspended production (*mothballing*), mere changes of legal form, mergers, split-ups, spin-offs, and the like. This longitudinal aspect of *PIA* remains largely unexplored in economic research on Brazil to date. Section 3 discusses ways to make the economic variables in *PIA* compatible over time and to correct for changes in surveying methods. In sections 4 and 5, I present methods to deflate the economic flow and stock variables—a task to be undertaken with much care since Brazil faces years of high inflation during the sampling period and changes legislation for the valuation of assets.

Auxiliary public files, such as databases with sector concordances or sector-specific deflators for various types of variables, are available from the web site *www.econ.ucsd.edu/muendler/brazil*. Auxiliary confidential files, such as firm classifications by the type of their economic curriculum, can no longer be maintained at *IBGE* for confidentiality reasons. Instead, the complete program files for data construction and estimation are available from *www.econ.ucsd.edu/muendler/brazil* to facilitate reproduction and future research. These programs are written partly for SAS 8 and partly for Stata 7.

At various instances, I mention short English variable names, sector definitions and regions in this report. Tables in section A (p. 55; sectors), section B (p. 65; regions) and sections C (p. 67; firm categories) and D (p. 74; economic variables) list sectors, regions, variables and their descriptions. It is my hope that *PIA* be fruitful for microeconometric research in and on Brazil.

1 *PIA*—What It Contains, and What Not

Pesquisa Industrial Anual is an annual survey of Brazilian mining and manufacturing firms and plants, conducted by the census bureau *IBGE* (*Fundação Instituto Brasileiro de Geografia e Estatística*). The database's inception dates back to 1966.

[1] Among the developing countries with similar longitudinal manufacturing databases are Chile, Colombia, Israel, Ivory Coast, South Korea, Mexico, Morocco, Taiwan, Turkey, and Venezuela (Levinsohn 1993, Griliches and Regev 1995, Roberts and Tybout, eds 1996, Clerides, Lach and Tybout 1998, Aw, Chung and Roberts 2000).

A systematic random sample, however, is first drawn with the census of 1985 and economic information is available beginning 1986. Until 1995, *PIA* surveys are based on the initial sample of 1986. Over the years, the surveys identify 10,507 legally established firms as potentially qualified for the *PIA* sample, out of which 9,155 firms exhibit manufacturing activity in at least one year. In its peak year 1990, *PIA* includes 9,755 firms (and captures the employment of 4.9 million workers and employees). By 1995, sample attrition brings the number of firms in *PIA* down to 6,618 (and employment to 3.8 million).

New firms enter the initial sample either because existing firms in the sample found them or because new firms are identified as sufficiently large 'greenfield' creations through a register at the labor ministry (*RAIS, Relação Anual de Informações Sociais*). The firms in *PIA* between 1986 and 1995 are regarded representative of the medium-sized to large firms in their respective sectors. No survey exists for 1991 due to a federal austerity program that temporarily suspends the survey. The questionnaire is slightly reduced in 1992, but the sampling method continues unaltered. Today, the database between 1986 and 1995 is often referred to as *PIA velha* ("old *PIA*").

In 1996, the sampling method is changed to systematically include small and newly established firms along with a complete survey of all firms with a labor force of 30 or more workers and employees. In its first year 1996, the complete *PIA nova* ("new *PIA*") includes 30,434 firms (but only 4.1 million workers and employees). By 2001, *PIA nova* covers 35,314 firms (and 4.0 million workers). For the present purpose, however, I mostly pay attention to those firms in *PIA nova* that are either present in *PIA velha*, too, or that are referenced as a longitudinally related firm by some firm in *PIA velha*. Exactly 5,510 firms satisfy this criterion.I refer to the linked *PIA velha*-*PIA nova* sample as 'Extended *PIA velha*' for 1986-1998. Since *PIA nova* does not report capital stock figures, the capital-related data become sketchier by the year and I curtail the extension in 1998. I compare the Extended *PIA velha* 1986-1998 sample to the complete *PIA nova* sample 1996-2001.

1.1 The *PIA velha* sample, 1986-1995

PIA velha (1986-1990, 1992-1995) is a continuous sample of formally established, medium-sized to large Brazilian mining and manufacturing firms for the years 1986 to 1990 and 1992 to 1995. The sample additionally embraces some medium-sized to large firms that are newly established between 1986 and 1993.

A firm is included in *PIA* only if at least half of its revenues stem from manufacturing and if it is formally registered as a tax payer with the Brazilian tax authorities (*Cadastro Geral do Contribuinte*, *CGC*, at the time).[2] The sample of firms in *PIA*

[2]As a consequence of the 50-percent-manufacturer requirement, some manufacturing firms are disregarded. A large computer manufacturer in Brazil, for instance, engages in computer assembly, sales of services, and rental of equipment. It goes unsampled in recent years because more than

velha is constructed in 1986 from three strata:

1. a non-random sample of the largest Brazilian mining and manufacturing firms (called *coleta especial*),

2. a random sample of medium-sized firms (*coleta complementar*), and

3. a non-random selection of newly founded firms (*coleta de novos*).

A firm that ever enters *PIA velha* through one of the selection criteria remains in the *PIA velha* sample unless it is legally extinct. Moreover, if an existing firm in *PIA* reports the creation of a new firm as a subsidiary or spin-off, or the like, the according new firm is included in *PIA* too.

The criterion for inclusion in the first non-random stratum is that the labor force of the firm either exceed an annual average of 1,000 employees in the census of 1985, or that its annual sales (*receita bruta*) in 1985 exceed a benchmark calculated in units of the governmentally administered price index at the time (OTN). The cutoff value corresponds to roughly BRL 200 million in 1995 (around USD 200 million in 1995). Exactly 984 firms enter *PIA* through this stratum. These firms make up for about 9.6 per cent of all observations (firm-year combinations) between 1986 and 1995, and about 10.8 per cent of the 9,151 firms ever observed in operation in *PIA velha*.

The second stratum comprises randomly chosen firms that are identified during the census of 1985 and whose annual sales in 1985 exceed a cutoff value corresponding to roughly BRL 100,000 in 1995 (around USD 100,000 in 1995).

The third non-random stratum of newly established firms comprises firms that emerge after the 1985 census. These firms are identified through the Brazilian labor ministry's register (*Relação Anual de Informações Sociais*). Only newly founded firms that surpass an annual average employment level of at least 100 persons are included. The inclusion process ends in 1993, however, so that greenfield creations are systematically observed only between 1986 and 1992. Even before 1993, the surveying method may not have been rigorously enforced at all times.

Due to the requirement that a firm be registered as a tax payer, firms in the so-called informal sector of the economy go unsampled by default. However, very few firms in the informal sector would attain a size that qualifies for one of the first two strata in *PIA velha*. Every firm in *PIA* is uniquely identified by its tax number *CGC*.

1.2 The *PIA nova* sample, 1996-2001

Like *PIA velha*, *PIA nova* (1996-2001) is a sample of formally established Brazilian mining and manufacturing firms. Contrary to *PIA velha*, however, *PIA nova* is

half of its sales stem from the latter two non-manufacturing activities.

designed to represent the Brazilian mining and manufacturing sector as a whole. It systematically includes a random sample of firms with labor forces of than 30 workers and employees.

There are only two strata in *PIA nova*. The first comprises a non-random sample of all medium-sized to large Brazilian manufacturers (more than 30 workers and employees; 38,201 firms). The second contains randomly selected small (at least five workers and employees) to medium-sized manufacturers (61,206 firms covered in at least one year between 1996 and 2001).

A firm is included in *PIA* only if at least half of its revenues stem from manufacturing and if it is formally registered as a tax payer with the Brazilian tax authorities (now *Cadastro Nacional da Pessoa Jurídica*, *CNPJ*; previously *Cadastro Geral do Contribuinte*, *CGC*). The sample of firms in *PIA nova* is drawn from two strata:

- a non-random sample of all Brazilian mining and manufacturing firms with a labor force of 30 or more workers and employees (*Estrato Final Certo*, receiving a complete questionnaire called *modelo completo*), and

- a random sample of small to medium-sized firms with a labor force of five to 29 workers and employees (*Estrato Final Amostrado*, receiving a simplified questionnaire called *modelo simplificado*).

Firms that enter *PIA nova* through the random sample are not retained over the years but subject to unconditional re-sampling as any other firm with five to 29 workers and employees. If a firm happens to be selected through the random sample for four consecutive years, it is dropped from the survey in the following year with certainty. In any future year, such a mandatorily dropped firm becomes subject to unconditional re-sampling again, as any other firm with five to 29 workers and employees. Contrary to *PIA velha*, if an existing firm in *PIA nova* reports the creation of a new firm as a subsidiary or spin-off, or the like, the according new firm is not necessarily included in *PIA*. It may happen to be included through random sampling or if it has a work force of more than 30 workers and employees.

Due to the requirement that a firm be registered as a tax payer, firms in the so-called informal sector of the economy go unsampled by default. Contrary to *PIA velha*, a more substantial number of firms in the informal sector would attain a size that qualifies for one of strata in *PIA nova*. Every firm in *PIA* is uniquely identified by its tax number *CGC/CNPJ*.

For sample selection, the Brazilian census bureau *IBGE* maintains a firm register *CEMPRE* (*Cadastro Central de Empresas*) on the basis of information from the tax register *CNPJ* (*Cadastro Nacional da Pessoa Jurídica*), from the labor ministry's *RAIS* (*Relação Anual de Informações Sociais*), and additional sources. In 2001, the firm register *CEMPRE* comprises 142,723 firms, out of which 28,057 firms with a work force of 30 or more workers and employees were selected for the non-random

Table 1: Strata of Extended *PIA velha*, 1986-1998

Year	Stratum 1	Stratum 2	Stratum 3	Other[a]	*Total*	Invalid[b]	*Valid*
1986	789	6,925	0	21	7,735	950	6,785
1987	798	6,950	0	35	7,783	949	6,834
1988	802	7,445	1,347	70	9,664	1,227	8,437
1989	811	7,497	1,400	11	9,719	1,232	8,487
1990	808	7,582	1,322	43	9,755	1,236	8,519
1992	796	6,706	455	75	8,032	737	7,295
1993	792	6,310	467	110	7,679	563	7,116
1994	769	5,684	480	83	7,016	263	6,753
1995	761	5,337	437	83	6,618	190	6,428
Subtotal[c]					*10,507*	*1,352*	*9,155*
1996[d]	747	3,512	391	72	4,722	40	4,682
1997[d]	711	3,239	358	70	4,378	15	4,363
1998[d]	663	2,883	326	68	3,940	8	3,932
Subtotal[c]					*5,278*	*45*	*5,233*
Total[e]	*916*	*8,187*	*1,635*	*183*	*10,921*	*1,356*	*9,565*
Obs.[f]	*9,247*	*70,070*	*6,983*	*741*	*87,041*	*7,410*	*79,631*

[a]Firms entering due to the legal or economic change of a sample firm.
[b]Category of economic curriculum (`catlife`) is 9.3, 9.35, or 9.99. See appendix C.2.
[c]Number of firms that appear (appear and manufacture) in at least one year of *PIA*.
[d]The according stratum is the firm's stratum in 1995.
[e]Number of firms that appear (appear and manufacture) in at least one year, counted in their first year of occurrence in *PIA*.
[f]Total number of firm-year observations 1986-1998.

sample. Another 11,135 firms with a work force of five to 29 workers and employees were selected for the random sample. 26,154 and 9,160, respectively, provide complete questionnaires.

1.3 Combining *PIA*s for the period 1986-1998

PIA velha (1986-1990, 1992-1995) is extended to include those firms in *PIA nova* (1996-1998) that are longitudinally connected. This allows to trace about three quarters of the firms in *PIA velha* beyond 1995. I refer to the so-linked *PIA velha*-*PIA nova* sample as 'Extended *PIA velha*' for 1986-1998.

The broader coverage of the mining and manufacturing sectors in *PIA nova* permits, in principle, the construction of a systematic (unbalanced) firm panel in

Table 2: Strata of *PIA nova*, 1996-2001

Year	Non-random stratum (C)	Random stratum (S)	*Total*	Invalid (C)[a]	*Valid* (C)[b]
1996	22,904	7,530	30,434	0	22,904
1997	21,935	7,909	29,844	0	21,935
1998	23,207	8,314	31,521	0	23,207
1999	23,933	8,521	32,454	0	23,933
2000	24,263	8,837	33,100	0	24,263
2001	26,154	9,160	35,314	0	26,154
Total[c]	*38,201*[d]	*23,005*	*61,206*	*0*	*40,008*[d]
Obs.[e]	*142,396*	*50,271*	*192,667*	*0*	*142,396*

[a]Only for firms in *Estrato Final Certo* (receiving a complete questionnaire called *modelo completo*). Category of economic curriculum (`catlife`) would be 9.3, 9.35, or 9.99. See appendix C.2.

[b]Only considering firms in *Estrato Final Certo* (with a work force of 30 or more).

[c]Number of firms that appear (appear and manufacture) in at least one year, counted in their first year of occurrence in *PIA*.

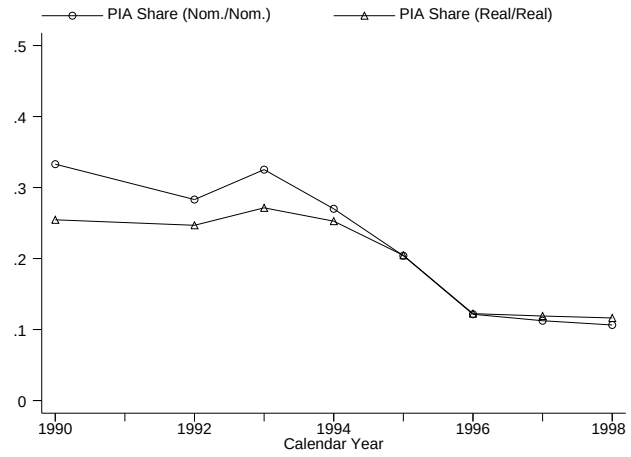
[d]The difference between the total of 38,201 stratum C firms and 40,008 valid firms comes about because some firms leave the stratum C over time but remain valid.

[e]Total number of firm-year observations 1986-1998.

the future. For the purpose of constructing a continuous database beginning in 1986 and extending to the present, however, only a subsample of the firms in *PIA nova* seems adequate. *PIA velha* follows the principle that a firm once sampled be sampled again in every subsequent year unless extinct. In addition, greenfield creations do not make it into the *PIA* sample after 1993. This suggests a natural way to connect the two *PIA*s between 1995 and 1996. I select those firms in *PIA nova* that are either present in at least one year between 1986 and 1995, too, or that are longitudinally referenced by a firm in *PIA velha*. In *PIA nova* (until 1998) smaller firms are randomly sampled every year, and thus potentially randomly replaced every year. As a consequence, not all firms that are present in *PIA velha* reoccur in *PIA nova*. In fact, of the 6,428 firms present in *PIA velha* 1995, only 4,682 appear in *PIA nova* in 1996. In addition, initial problems in the register of firms for the *PIA nova* sample result in the omission of otherwise qualified firms.

The sample drop in 1995 can be a concern for estimation. However, the drop proves to be random and exogenous to the sample when conducting production function estimation (Muendler 2003b, Muendler 2003c). Various treatments (such as the use of time indicators, period indicators or year indicators) do not show a significant impact on production function or productivity estimates.

Table 1 presents an overview of the size of the three strata in *PIA velha*. No economic information is available for the 'invalid' firms in the second-last column.



Sources: Brazilian national accounts 1990-1998 (value added in manufacturing).
Own calculations (total value added among manufacturers in *PIA*).

Figure 1: Value added share of *PIA* in Brazilian manufacturing, 1990-98

However, their observations are kept in the sample to provide longitudinal information. These firms are initially identified as qualified, but, at the time when the *PIA velha* survey is conducted, they have gone out of business, turned out to be mainly non-manufacturing firms, or have been absorbed by another firm. As the exact results of the economic census of 1985 become known between 1986 and 1987, the sample of valid firms grows from around 6,800 firms in 1986 to about 8,500 in 1990. By 1992, it is down to roughly 7,300 firms again and drops to about 6,400 firms in 1995. Table 1 also exhibits the evolution of the Extended *PIA* sample for 1986 through 1998.

The *PIA nova* sample is broader in coverage. It includes small firms, and medium-sized to large firms in a more representative way. Table 2 shows the evolution of the *PIA nova* sample similar to *PIA velha* in table 1. Rather than using three principle strata related back to initial coverage in 1986 as in *PIA velha*, *PIA nova* is based on two strata that relate to employment information from the firm register of Brazilian mining and manufacturing firms in the respective preceding year.

Figure 1.3 shows the share of *PIA*'s firms in the Brazilian manufacturing sector as a whole (only longitudinally related firms are kept from *PIA nova*). *IBGE*'s national accounts office reports consistent value added figures for Brazilian manufacturing since 1990. The value added figures for *PIA* are constructed using the deflation methods discussed in section 4. The medium-sized to large firms in Extended *PIA velha* lose in market share relative to other Brazilian manufacturers. The decline occurs before the drop in sample size in 1996. In fact, the firms in Extended *PIA velha* lose importance since 1993. Exit reduces the sample and becomes more frequent after trade liberalization in the early nineties. Also, Brazilian mining

firms and manufacturers that were smaller before are likely to gain in relative size.

1.4 Variables

Both *PIA velha* and *PIA nova* contain three main groups of variables: (a) Information about longitudinal relations across firms, (b) balance sheet and income statement information, and (c) economic information beyond the balance sheet and income statement. The according variables receive varying names and are kept in different ways over the years, but their individual content generally remains similar if not unaltered over time. Among the longitudinal information in group (a) are variables that indicate the state of activity of a firm in a given year (such as whether it operates all year, only part of the year, or exits) and its structural changes (such as whether it emerges from a pre-existing firm or whether it creates a spin-off firm itself, and the like). Variables in group (b) include cost, revenue, and profit information, detailed in a manner similar to a typical Brazilian income statement, and asset and liability figures until 1995, detailed in a manner similar to a typical Brazilian balance sheet. Variables in group (c) go beyond the balance sheet and income statement and include data such as investment flows by type of asset, numbers of workers and employees, and a variable to indicate the origin of the firm's majority capital in *PIA velha*.

One of *PIA*s quite unique features is that it allows to distinguish between foreign and domestic machinery acquisitions for the years 1986 until 1995, and to distinguish between foreign and domestic intermediate goods purchases since 1996. In addition, two quite detailed variables indicating the state of a firm's economic activity allow to precisely trace the firms' operations over time so that researchers need not resort to assumptions about a firm's likely destiny when observations are missing. The variable indicating the origin of a firm's majority capital, however, is generally regarded as little informative. A main reason is that several firms in *PIA* are subsidiaries of Brazilian holdings which in turn are foreign-owned. Some of these subsidiary firms would interpret the variable in a strict sense and claim to be Brazilian-owned, while other firms would interpret the variable in a broader sense and indicate foreign ownership. As a consequence, the variable is imprecise.

The following section 2 exploits the information of the longitudinal variables in group (a) in order to follow firms over time in an unbalanced panel and to calculate the economic age of firms. Sections 3, 4, and 5 are dedicated to constructing consistent economic variables from the variables in groups (b) and (c) over time, and to their respective correction for inflation.

Table 3: State of Activity

State of Activity	*PIA velha*	*PIA nova*
in operation	1	1
in installation phase	2	2
suspended production part of year	3	3
extinct	4	4
suspended production all year	5	5
extinct in earlier year	6	6, 7
mainly non-manufacturing	7	8
other	8	9, 10, 11, 12, 13, 14

2 Longitudinal Relations between Firms

The longitudinal relations between firms in *PIA* have not systematically analyzed so far. Most researchers choose to work with *PIA* at various aggregate levels but not at the firm or plant level, partly because access to the confidential firm or plant data is restricted to researchers who temporarily affiliate themselves with *IBGE* Rio de Janeiro, while *IBGE* shares data on aggregate levels. Second, throughout the period from 1986 to 1998, the internal data analysis and critique at *IBGE*'s division for the manufacturing sector is designed to check data for their consistency within a given year but not to check their consistency across years.

The present section documents the use of longitudinal information in *PIA velha* and *PIA nova*. This information serves as a key component for the construction of an unbalanced firm panel. It needs to be known if and when a firm exits, whether data for future years are simply missing or whether a firm chooses to temporarily suspend production, whether an exiting firm survives in different legal form or really stops producing, and the like. As a side product of this information, the economic age of a firm is inferred.

2.1 States of activity and types of change

Both *PIA velha* and *PIA nova* contain two variables that are intended to reveal precise information about the economic and legal state of a firm. The *state of activity* (`state` *situação cadastral* indicates whether a firm operates in a given year. Table 3 summarizes the level of detail of the according variable in *PIA velha* and *PIA nova*.

A second variable can be translated as *structural change* or *change of economic/legal status* (*mudanças estruturais*; variable: `change`). It records changes to the firm's legal and economic status. The classification is considerably simplified in *PIA nova* (variable: `'change'`) as compared to the earlier *PIA*. In order to make

Table 4: Change of Legal or Economic Status

Change of Legal/Economic Status	*PIA velha*	*PIA nova*		
	`change`	'`change`'	`state`	additional
no change	.	.		
merger	1	1		> 1 predec.
absorbed into other firm	2	3	4, 5	
absorbing other firm	3	3	1, 2, 3	
complete split-up into successor(s)	4	1		1 predec.
partial spin-off into existing firm	5	2		succes. old
partial spin-off into new firm	6	2		succes. born
dissolved	7	-	4, 6, 7	
(parts) rented out to other firm	8	(4)		
renting (parts of) other firm	9	(5)		
other[a]	10	6		

[a] As explained in the according manuals, the category 'other' is systematically used in *PIA velha* (IBGE 1986a, IBGE 1986b). For example, it is generally assigned to the firm that arises from a merger. With *PIA nova*, the use of 'other' becomes restricted to otherwise unclassified cases (IBGE 1996a).

this variable compatible between *PIA velha* and *PIA nova*, algorithms as indicated in table 4 are applied.Two further variables indicate the month and year in which the change occurs (`chmon` and `chyr`).Knowledge about this timing is important to properly deflate the according economic variables.

PIA velha also documents one so-called *tax number link* (*CGC de ligação*) and *PIA nova* up to three such *tax number links*. They serve to connect firms over time so that successors and predecessors are identified. A peculiar feature of these *tax number links* both in *PIA velha* and *PIA nova* is that they are used as connectors for the referencing firms as well as connectors for the firm that is being referenced. Hence, they change their meaning depending on the value that the variable `change` takes. Firms are asked to provide the year of their foundation in *PIA velha*, and the same information is available for firms in *PIA nova* through tax registers and *IBGE*'s own register of known Brazilian manufacturers (*Cadastro Básico de Seleção* for *PIA nova*).Column five ('additional') in table 4 exploits these two types of additional information to make the variable *change of legal/economic status* (`change`) compatible between *PIA velha* and *PIA nova*.

2.2 Reclassifications and error corrections

Table 5 summarizes my reclassifications and corrections for the variables *state of activity* (`state`) and *change of legal/economic status* (`change`). In the case of sev-

Table 5: Reclassifications and Error Corrections

Correction	if, in a given year,
`change`:=2	`change`=3, and `state`=4 or 6
`change`:=3	`change`=2, `state`=1, and firm continuously present in *PIA*
`state`:=2	`state`=5 or 8, no sales, and year=first year of appearance
`state`:=5	`state`=8, no successor, and `state`=3, 4, 5, or 6 in following year
`state`:=4	`state`=8, positive sales, and `change`=1, 2, 4, or 7
`state`:=4	`state`=1, `change`=10, and year is last year
`state`:=5	`state`=8, `change`=8, and no sales
`state`:=5	`state`=8, `change` empty, no successor, and no sales
`state`:=6	`state`=5 and year=last year of appearance (and before 1998)
`state`:=6	`state`=8, no sales, firm has successor, and `change`=1, 2, 4, or 7
`state`:=6	`state`=8, no sales, no successor, and `change` empty

eral firms, the variables `state` and `change` exhibit contradictory patterns over time. These conflicts are often hard to resolve. Therefore, I generally choose to sort firms out whose longitudinal data exhibit such contradictions. However, some unnecessarily vague classifications or obvious mistakes are corrected. Whereas the upper four reclassifications seem to be due corrections, the reclassifications in the lower part of table 5 seem justified but not necessary. A telling example may be the reclassification to `state`:=5 in line 7. The combination of economic circumstances (`state`=8, `change`=8, no sales) suggests that a firm rents its equipment to another firm while it realizes no sales of its own—hence, it suspended own production in fact. (There are 44 such observations in *PIA*.)

More often than necessary, firms choose the category 'other' as `state` or `change` to classify the type of change they undergo. Natural reclassifications are listed in table 5. Finally, firms may sometimes have alleged incentives to misrepresent the category of `change`. An example is that a firm merely alters its legal form with no economic consequences for the production process—in order to realize advantages in taxation or at financial markets, say. Especially when taxation is concerned, this firm would typically claim in the questionnaire that its predecessor is extinct (`change`=7) without any remainders, but would still provide the *tax number link* to this predecessor and possibly add hand-written observations (while `state`=8). The correct category of `change` would be 'dismantled into successor' (`change`=4). The reclassifications in table 5 take this and similar misrepresentations into account.[3]

The information in `chmon` and `chyr` indicates in what month of a year the recorded `change` occurs. Firms often report a month of change `chmon` in later years that is different from the `chmon` in earlier years, or they do not report a month of

[3]The alternative of manually reviewing several hundreds to thousands of hand-written observations for every year in *PIA* seems an undue effort.

Table 6: Proper Parents and Children for *PIA*'s Family Tree

Properly referencing firms (proper parent), through *tax number link(s)*
state=4 or 6, change≠10, and year=effective exit year
state=4 or 6, and change=1, 2, 4, or 7
state=1, change=10, year=effective exit year, and `indcor` records change[a]
Properly referenced firms (proper child), through *tax number link(s)*
change=3, and successor firm identified
change=10,[b] and successor firm identified

[a]The variable `indcor` is an indicator variable only available for *PIA velha* between 1992 and 1995. It states whether a firm merely changes its tax number.

[b]See footnote *a* in table 4.

change initially but provide one later. Errors in this variable may slightly affect the method of inflation correction proposed for flow variables in section 4.1. In general, I correct the information in `chmon` so that the longest justifiable survival time of the firm results, that is to use the latest exit month reported when information is contradictory. This procedure makes errors from the correction method in section 4.1 the least likely. Also, omissions or errors in the variable `chyr` affect the construction of the 'family tree' of firms, that is the 'parent-child' relations between firms (see section 2.4). I insert missing information in `chyr` if this information is consistently provided in later years.

2.3 Effective suspension and exit times

It proves helpful to know the effective times of a firm's exit and the exact beginning of periods of temporarily suspend production (mothballing). In *PIA*, recorded exit years are often preceded by missing years or years with special observations but no sales (`state`=8 or `change`=10, 'other'). Similarly, years of suspended production are often surrounded with periods of missing years or years with special observations. I calculate the effective exit (suspension) year for every firm (`effextyr` and `fstsusyr`, respectively) as the earliest year preceding an observed exit (suspension) year after which no proper year is observed until exit (suspension) is recorded indeed.(suspension) is recorded indeed.

2.4 Identifying longitudinal links in a 'family tree'

A simple way to trace firms over time is to construct a family tree that records the parent-child connections between firms. This approach is briefly outlined here. The following subsection 2.5 below is devoted to the more involved task of classifying the economic curriculum of firms, whether they are connected to other firms or not.

A family tree of firms and their predecessors can be arranged in a list where the lines are of the form:

line 1	Firm D	←	Firm B	←	Firm A
line 2	Firm D	←	Firm C		
...					

In this setup, the oldest forefather of a firm lies the farthest to the east, and all children are listed below each other in the west.

The particular way in which *PIA*'s longitudinal information is arranged suggests to build this family tree up from two sides. The *tax number link(s)* are used both with the referencing firm (the parent) and with the firm that is being referenced (the child). These *tax number link(s)* change their meaning according to the value that the variable `change` takes. The upper part of table 6 shows which firms are selected as properly referencing firms (proper parents), thus building-up the family tree from the east. Similarly, table 6's lower part shows firms that are selected as being properly referenced (proper children) so that the table is built-up simultaneously from the west.

Due to the arrangement of the longitudinal information in *PIA* (especially in *PIA velha*), several but by far not all entries occur twice in *PIA*—justifying the double build-up effort. As it turns out, double entries in *PIA*'s family tree never contain conflicting information for *PIA*—a reassuring fact given that *PIA*'s data between 1986 and 1998 are generally not submitted to dynamic checks across years. The maximal number of 'generations' in the family tree for *PIA* (1986-1998) are three parent-child relations. However, some alleged predecessors are not contained in *PIA* (indicated by the variables `pr1noshw`, `pr2noshw`, and `pr3noshw`). Overall, about a tenth of all firms in *PIA* (1,099 firms) are identified as 'children' of some parent in or out of sample.

2.5 A firm's 'economic curriculum'

For the construction of an unbalanced panel and its econometric application, one ought to know both why a firm enters the data set and why it drops out. A firm that enters the data as a mere legal successor of a previously surveyed firm has to be treated differently from a greenfield creation. Similarly, a firm that is dismantled but lives on in many successor firms is to be clearly distinguished from a firm that stops producing for good. The variables `state` and `change`, together with complementary information, allow for a fairly precise characterization of the economic curriculum of a firm in *PIA*.

For many econometric applications a few categories of entry ('old' or 'new', say) and exit ('active', 'suspended', or 'shut-down', say) may suffice. However, to arrive at such simple categories, firms generally need to be sorted according to a more

Table 7: Simplified Categories of Entry, Extended *PIA velha* and *PIA nova*

Type of Entry (`catentsi`)	Original Category[a]	Number of firms Ext. *PIA* 86-98	*PIA nova* 96-01[b]
1: old firm	all categories except below	10,021	37,833
2: new firm	2.1, 2.4, 4.11, 4.14, 8.4, 9.2	892	2,119
9: problem firm	9.1	8	56
Total		*10,921*	*40,008*

[a]See appendix C.1.
[b]Only considering firms in *Estrato Final Certo* (with a work force of 30 or more).

detailed roster first. Appendices C.1 (p. 67) and C.2 (p. 70) document the two fine rosters for entry and exit that are used.

Tables 7 and 8 present a condensed classification, derived from the detailed categories in appendices C.1 and C.2, respectively. Some classifications are certainly debatable. For example, a spin-off firm created by an existing firm is considered a new firm with zero economic age in the categorization of table 7. However, it might also be justifiable to categorize a spin-off as old firm with the age of the economic predecessor. Table 7 treats firms that emerge from a complete split-up of their predecessor in this latter way, for example. The idea is that spin-offs are founded to stand alone and gain experience on their own, moving away quickly from the parent firm's original knowledge, whereas successor firms from a complete split-up may benefit more from the initial knowledge incorporated in their plants, continuing the business of their predecessor. Clearly, this classification is a judgement call.[4]

Tables 9 and 10 cross-tabulate tables 7 and 8 and show the number of firms in Extended *PIA velha* and *PIA nova* that are observed with positive manufacturing sales in at least one year.

2.6 A firm's economic age

The economic age of a firm is of interest for its own sake and can help check longitudinal relations in addition. There are several sources to infer the age of a firm in *PIA*. The *PIA velha* questionnaire asks for the firm's founding year; tax registers and *IBGE*'s own register of known manufacturers (*Cadastro Básico de Seleção*) record the year of a firm's legal creation; and the year of first appearance in *PIA* together with an observed `state` 'in installation' may be indicative. As it turns out, these

[4]These difficulties in classification do not only arise in the case of firms. One encounters similar problems with plants. If an existing firm opens a new plant, for example, it is not clear whether the new plant should be assigned the age of the founding firm (as it receives human capital and implicit knowledge transfers) or be counted with zero age (as it starts a new production process).

Table 8: Simplified Categories of Exit and Suspension, Extended *PIA velha* and *PIA nova*

Type of Curriculum (`catlifsi`)	Original Category[a]	Number of firms Ext. *PIA* 86-98	*PIA nova* 96-01[b]
1: always active	all categories except below	6,189	38,365
2: suspends, returns, no exit	3, 3.1, 5.3, 5.311-5.313, 8	726	1,264
3: suspends, returns, exits	3.2, 5.314, 5.32	411	3
4: exits	1.4, 2, 5.14, 5.2	2,114	248
6: reclassification possible	9.1, 9.15, 9.2, 9.35	128	128
9: problem firm	9.3, 9.99	1,353	0
Total		*10,921*	*40,008*

[a]See appendix C.2.
[b]Only considering firms in *Estrato Final Certo* (with a work force of 30 or more).

sources contain partly contradictory information. Common reasons are that firms only register their creation at the tax roll with a delay and that some firms only enter an approximate founding year in the questionnaire. In addition, recent copies of the tax register contain truncated information in the year 1966; that is, firms founded before 1966 are recorded as created in 1966. There are several possible sets of criteria to infer a firm's founding year from this conflicting information. The set of criteria applied here is presented in the upper half of table 11.

The founding year may not reflect the true economic age of a firm. For example, reasons of taxation or legal causes may induce a firm to change its legal status while it remains the same economic entity. Clearly, such a firm should be considered older than the registration year of the most recent tax number. The founding year corresponds to the 'legal age' of a firm, whereas its 'economic age' is determined by the impact of its predecessors. Again, there are several criteria to infer an adequate economic age of firms in *PIA*. In one way or another, they all make use of the information in a firm's family tree as discussed in subsection 2.4 above. The lower part in table 11 describes a possible algorithm.

2.7 Regional classifications

The variables `region` and `uf` indicate the location of the legal headquarters of a firm (see appendix B for an overview of Brazil's regions). The location of the headquarters need not coincide with the region of a firm's main economic activity or value creation. In principle, a value-added based reclassification of the variables `region` and `uf` could be inferred from plant-level information in *PIA* for a number of firms, but not for all firms since there is no complete overlap between plant-

Table 9: Cross-tabulated Simplified Entry and Life Categories, Ext. *PIA velha*

Type of Life (`catlifsi`)[b]	Type of Entry (`catentsi`)[a] 1: old firm	2: new firm	9: probl.	*Total 86-98*
1: always active	5,551	636	2	*6,189*
2: suspends, returns	656	70	0	*726*
3: suspends, exits later	391	20	0	*411*
4: exits	1,968	144	2	*2,114*
6: to be reclassified	117	7	4	*128*
9: problem	1,338	15	0	*1,353*
Total	*10,021*	*892*	*8*	*10,921*

[a]See appendix C.1.
[b]See appendix C.2.

level and firm data. The regional variables exhibit strange observations in a few instances. Entries below '1' or above '5' in the variable `region` are set to missing. In some cases, missing values for the variable region are inferred from `uf`, the more detailed variable. Finally, I classify the region of a firm to the one in the preceding or following year if an observation is missing, depending on whether a change of region occurs or not.

2.8 Sector classifications

Firms in *PIA velha* are classified into sectors according to *Nível 100* (for a description of sectors see appendix A). In *PIA nova* the sector classification is changed to *CNAE* (*Classificação Nacional de Atividades Empresariais*). Since *CNAE* is more detailed, firms in *PIA nova* are re-classified to *Nível 100* (see appendix A for a translation key). However, there is a break between *PIA velha* and *PIA nova*. Many firms apparently change sectors between 1995 and 1996. This may have to do with the fact that outdated firm classifications in *PIA velha* are corrected in *PIA nova*. As a consequence, adjustments over time may be in place. If one wants to use the years 1992 through 1998, for instance, it may be worthwhile to only use sector classifications from *PIA nova*. However, since I choose to cover the entire period from 1986 through 1998, sector classifications of *PIA velha* seem to be more adequate and are used. A downside of these adjustments is, of course, that changes in a firm's product range are disregarded.

Table 10: Cross-tabulated Simplified Entry and Life Categories, *PIA nova*

Type of Life (`catlifsi`)[b]	Type of Entry (`catentsi`)[a] 1: old firm	2: new firm	9: probl.	*Total 96-01*[c]
1: always active	36,262	2,053	50	*38,365*
2: suspends, returns	1,209	55	0	*1,264*
3: suspends, exits later	3	0	0	*3*
4: exits	237	11	0	*248*
6: to be reclassified	122	0	6	*128*
9: problem	0	0	0	*0*
Total	*37,833*	*2,119*	*56*	*40,008*

[a]See appendix C.1.
[b]See appendix C.2.
[c]Only considering firms in *Estrato Final Certo* (with a work force of 30 or more).

Table 11: Effective Creation Time

Algorithm to find effective **legal founding year** (`effborn`)
Set `effborn` to registration year in *IBGE*'s most recent register (*Cad. Básico*)
Replace `effborn` by reported year in *PIA velha* **if** `effborn` is 1965 or 1966
Replace `effborn` by year of first appearance in *PIA* **if** first appearance earlier
(Sort firm out **if** registration year later than first appearance in *PIA*)

Algorithm to find effective **economic founding year** (`econborn`)
Set `econborn` to `effborn`
Replace `econborn` by founding year of predecessor **if** firm emerges from split-up or spin-off
Replace `econborn` by founding year of absorbed predecessor **if** predec. large (avg. labor force of predec. at least two thirds of firm's avg. labor force)

3 Consistency of Economic Variables Over Time

Between 1986 and 1998, *PIA* suffers two structural breaks. The questionnaire is slightly simplified and partly downsized in 1992. In 1996, with the creation of *PIA nova*, several economic variables drop out, some few are added, and the aggregation of variables from the balance sheet and income statement changes. To obtain time consistent economic variables for the entire period from 1986 to 1998, a few adjustments are in place.

3.1 Time-consistent economic variables

Table 16 in appendix D (p. 75) documents the manner in which I construct consistent economic variables. In the present section, I discuss main concerns.

Some changes in variable definitions are noteworthy. Gross sales, including taxes and subsidies, incorporate changes that are not due to market forces. Net sales are used instead. However, sales figures in *PIA velha* and *PIA nova* seem to be most compatible when gross sales are considered both between 1986 and 1995 (including export subsidies, credit subsidies such as *IPI*) and between 1996 and 1998 (including the usually small additional revenues from services). The according variable is named `grssales` in table 16 (p. 75). At any level net of subsidies or service revenues, sales figures are not immediately compatible across *PIA velha* and *PIA nova*—due to a re-grouping of the variable definitions in the questionnaire in *PIA nova*. However, there is an alternative. Make the assumption that export and credit subsidies as well as service revenues move in fixed proportion to total sales within any given year. Taxes are generally calculated in fixed proportions of total sales. Then one can calculate adjusted net sales as the fraction of net sales that is due to other economic activity than taxes, subsidies and service revenues. The according variable in table 16 (p. 75) is `sales`.

The redefined salary variable in the *PIA nova* questionnaire makes a similar effort necessary for wages. I distribute the (extra position) of 'gratuities and bonuses' linearly between blue and white-collar salaries for *PIA velha*. These gratuities and bonuses are included in the respective salary variables in *PIA nova*.

In *PIA nova*, computer acquisitions are lumped together with other acquisitions. The variable `acqother` reflects the correct sum for all years 1986-1998 while `acqcomp` gives the value of computer acquisitions between 1986 and 1995. The same classification applies to the asset retirements of computers and other capital goods (`aslother` and `aslcomp`).

For reasons hard to understand today, intermediate goods acquisitions did not receive a position of their own in the *PIA velha* questionnaire. The best proxy for intermediate goods acquisitions is the variable called 'other costs and expenditures' (*outros custos e despesas*). This weakness of *PIA velha* makes it necessary to construct a similar (and equally noisy) variable for *PIA nova*. I add purchases of inter-

mediate goods'(*compras de matérias-primas, materiais auxiliares e componentes*), the total of combustibles, electric energy, and services consumption (*consumo de combustíveis*, *compra de energia elétrica*, *consumo de peças*, *serviços industriais*, and *serviços de manutenção*) as well as shipping costs (*fretes e carretos*) and other operational cost (*demais custos e despesas operacionais*) in *PIA nova*.

The variables `wagetop` and `wagewh`—representing the salaries of top managers (firm owners) and white-collar employees, respectively—cannot be made exactly compatible between *PIA velha* and *PIA nova*. The reason is that *PIA velha* and *PIA nova* treat upper-level managers (*diretores*) in a different manner. While *PIA velha* includes upper-level managers' salaries in the variable `wagetop` (together with top managers and firm owners), *PIA nova* includes these managers' salaries in `wagewh` (together with employees).

During the first years of *PIA velha* (1986-1990), firms are asked to present the steps of their asset revaluation under inflation in the *PIA* questionnaire (emph-correção monetária). However, the according fields in the questionnaire are arranged in a contradictory manner (asset acquisitions, for example, appear before the monetary correction column, rendering it unclear at what stage the appropriate correction should be presented). This and further problems made the variables never pass the data critique. Consequently, the fields are dropped after 1992. I include only stock variables such as `aspmasum` from these fields in the database. Similarly, variables such as final stocks of vehicles and computers could be included. Since they reflect final values after all monetary corrections, these variables are not likely to suffer from contradictory monetary correction steps.

A time-consistent variable `profit` is constructed for profits *before* taxes. No consistent series of profits *after* taxes can be derived because questionnaires in *PIA velha* (1986-95) and *PIA nova* (from 1996 on) differ. Before 1996, the reported profit figure is profit *after* tax and workers' participation, and the latter two costs are reported. Since 1996, the reported profit figure is profit *before* tax and workers' participation, while the latter two costs are not reported. So, only a series of profits *before* taxes is constructed that is consistent in this respect. For this purpose, one can add back anticipated taxes and workers' participation to after-tax profits in *PIA velha*. In a strict sense, the proposed profit series still suffers from a slight incompatibility for the years 1989 and 1990. The reason is a legal change in 1988 that is only accounted for in the *PIA* questionnaire after 1990. Social contributions under *lei 7689 de 15/12/1988* reduce profits in addition to the tax payments from 1989 on. Only the questionnaires after 1991 include these payments explicitly. However, the reported costs of social contributions under *lei 7689 de 15/12/1988* are small on average (2.6 percent between 1992 and 1995) so that the implied error in the profit figures in 1989 and 1990 should be small. In addition, not given any other choice, firms in 1989 and 1990 are likely to report this cost under taxes so that it would be accounted for.

Finally, observe that both the variable `difstock` and the variable `intmdif` are

calculated departing from cost information in the income statement. Therefore, a positive value means a *decrease* in stocks. I use these variables to arrive at the full production on the output side and the full use of intermediates and materials at the input side.

3.2 Missing values in *PIA velha*

In *PIA velha*, zero values of observations cannot be distinguished from missing values. Depending on the type of variable, I choose different procedures to decide which value should be regarded as missing and which one as zero. In the case of sales, for instance, it is likely to make little difference whether a value is missing or zero. The firm is regarded as not in operation. However, when observations of gross investment are missing, as another example, it does matter whether a value is zero or missing. It also becomes harder to decide whether no investment is undertaken indeed or whether investment is incorrectly reported in the questionnaire. In this particular case, I consider a value of gross investment as zero when the according asset retirements figure is not missing, and as missing otherwise. Similar criteria are applied to other variables. *PIA nova* properly distinguishes between missing and zero values.

3.3 Rebasing to a common currency

During the sampling period of *PIA*, the Brazilian currency changes four times (but only twice the currency units are altered). All variables in the *PIA* database are in current currency of the according year. Table 12 shows how the figures in *PIA* are rebased to one common year. The factors in table 12 refer to the latest Brazilian currency *Real* (BRL, introduced in July 1994).

3.4 A comment on plant data in *PIA velha*

At the plant level (*unidade local*), several further precise variables are available in *PIA velha*: For example, the consumption of combustibles and electric energy in production and more precise information about the use of intermediate products. While it seems hard to break firm-level data (such as investment flows or the capital stock which are not directly observed at the plant level) down to the plant level, it might seem a natural extension of the database to aggregate the plant data into firm data and then use the more complete database. However, this approach proves little rewarding.

The sample of plants in *PIA velha* is constructed in a manner very similar to the sample of firms. The non-random part comprises the plants of the leading firms (in stratum 1; see table 1, p. 6). The random part, however, consists of plants that are randomly drawn themselves—independently of the firms that enter *PIA*

Table 12: Rebasing to Brazilian Real as Common Currency

Year[a]	Currency[b]	in BRL (July 1994)[c]	change in[d]
(1985)	*Cruzeiros*	1/(2.75*1,000,000,000,000)	
1986	*Mil Cruzados*	1/(2.75*1,000,000)	March 1, 1986
1987	*Mil Cruzados*	1/(2.75*1,000,000)	
1988	*Mil Cruzados*	1/(2.75*1,000,000)	
1989	*Mil Cruzados Novos*	1/(2.75*1,000)	
1990	*Mil Cruzeiros*	1/(2.75*1,000)	
(1991)	*Mil Cruzeiros*	1/(2.75*1,000)	
1992	*Mil Cruzeiros*	1/(2.75*1,000)	
1993	*Mil Cruzeiros Reais*	1/(2.75*1,000)	August 1, 1993
1994	*Reais* (BRL)	1	July 1, 1994
1995	*Reais* (BRL)	1	
1996	*Reais* (BRL)	1	
1997	*Reais* (BRL)	1	
1998	*Reais* (BRL)	1	

[a]December of the year. *PIA* is based on end of year values.
[b]As used in the *PIA* micro-data base. *Mil* means 1,000.
[c]The factors need not apply to published aggregate figures from *PIA*.
[d]Applicable to monthly deflators.

velha. Therefore, only very few plants and firms overlap. As a consequence, a joint database of plant-level data, aggregated into firms, and merged firm-level data results in a sample of considerably less than 1,000 firms. Depending on how one counts firms with missing data, the usable sample may only comprise some 200 to 400 firms. In addition, these firms are concentrated in very few sectors. Compared to a sample of more than 9,500 firms, the little gain in additional information from merging plant-level and firm-level information does not seem justified.

Plant data from *PIA nova* have not been available to me to date.

4 Deflating Flow Variables

Brazil faces periods of extremely high inflation until the *Plano Real* finally succeeds in bringing down inflation in July 1994. The average annual inflation rate between January 1986 and December 1994 is 820 per cent (according to *INPC*), while the *Plano Real* brings inflation down to a yearly average of 8.8 per cent between January 1995 and December 1998 (*INPC*). As a result, the data, especially in *PIA velha*, need to be carefully corrected for inflation.

Firms in both *PIA velha* and *PIA nova* are asked to provide economic variables in the same manner as they would present the figures in their balance sheet or income statement. However, civil law and the according accounting orders of the federal government are often designed as if inflation did not exist. Moreover, several officially imposed price indices deliberately understate true inflation. Together, these two factors create substantial difficulties for the researcher to arrive at realistic real values of the variables. The legal stipulations affect flow and stock variables in quite different ways. I will discuss both groups of variables separately below.

In *PIA velha* and *PIA nova* firms are asked to report economic numbers referring to the calendar year of the survey. Firms whose business year does not coincide with the calendar year are required to adjust the numbers accordingly. The monetary correction for inflation has to be conducted following *Legislação Societária* (e.g. IBGE 1994). *PIA*'s instructions mandate explicitly that firms not apply *Correção Monetária Integral* ('complete monetary correction') which contain a set of rules for monetary adjustment of both flow and stock variables. Instead, firms are asked to follow *Legislação Societária* (see e.g. IBGE 1994, p. 48). Brazil's *Legislação Societária* is grounded in *Lei n. 6404 de 15-12-76*. This law and the according governmental orders, still in force as of 2001, prohibit the monetary correction of flow variables. The law does, however, specify procedures for revaluing assets under inflation.

All price index, tariff, exchange rate and interest rate series mentioned in the present section can be downloaded from *www.econ.ucsd.edu/muendler/brazil*.

4.1 Correcting for ignored inflation

Since Brazil's *Legislação Societária* does not allow to deflate flow variables, all economic variables in *PIA* that stem either from the firm's income statement or relate to salaries are simple sums of the firm's monthly (or possibly daily) figures. Under high inflation, a simple sum depresses the January values considerably and correctly represents just a about the (late) December values. There seems to be no direct way to recapture more precise inflation-adjusted figures. I therefore use the following approximation to a more realistic value for the flow variables.

Call the observed value of the respective flow variable in year t $\tilde{X}_t$. $\tilde{X}_t$ is the value reported by *PIA* but it reflects the wrong sum of not corrected nominal flow values.

Similarly, call the correct real value of the firm's annual figure X_t. Suppose that the firm has a proper monthly accounting system and that it simply sums its monthly figures up to the annual figure, for which the *PIA* questionnaire asks. Suppose also that the monthly accounting system correctly adjusts for inflation over the course of the month. If one finally supposes that the firm's annual figures suffer from no seasonal fluctuations over the course of the year, the wrong annual value is

$$\tilde{X}_t = \frac{X_t}{12}\frac{\pi_{jan,t}}{\pi_{dec,t}} + \frac{X_t}{12}\frac{\pi_{feb,t}}{\pi_{dec,t}} + \ldots + \frac{X_t}{12}\frac{\pi_{dec,t}}{\pi_{dec,t}}, \tag{1}$$

where $\pi_{month,t}$ denotes the according monthly price index.

This equation states: If the annual figures are evenly distributed across months ($\frac{X_t}{12}$ is the same every month) then one can commit the same error as the firm had to commit when applying *Legislação Societária*. We can simply downsize the January figure by the inflation rate between January and December, downsize the February figure by the inflation rate between February and December, and so forth, and then sum all these inappropriate monthly figures up to the wrong annual figure $\tilde{X}_t$. This is the error that all firms in *PIA* are forced to commit when presenting their figures for flow variables. Of course, one can undo this error by solving (1) out for X_t. This yields

$$X_t = \frac{12 \cdot \pi_{dec,t}}{\pi_{jan,t} + \pi_{feb,t} + \ldots + \pi_{dec,t}}\tilde{X}_t. \tag{2}$$

Appropriate price indices for all flow variables in *PIA* are available or can be constructed. I apply equation (2) to every single flow variable in *PIA* and arrive at corrected annual values. These values come closer to a realistic real annual value than the raw number in *PIA* does—even if one has no reason to believe that there are no seasonal fluctuations over the year. I apply the correction of equation (2) to every flow variable in *PIA*. For firms that got out of business during a year, the variable `chmon` indicates the month of effective exit. I use the formula only up to the respective exit month. A remaining task is to find or construct appropriate monthly price indices for each flow variable.

4.2 Price indices for 1986-2001

Depending on the circumstance, either sector-specific or industry-wide price indices are more appropriate to deflate flow variables. In principle, the use of an industry-wide (or even economy-wide) price index has the benefit of maintaining the relative price structure across sectors, regions and time, while it supposedly captures all monetary effects on the price level. Moreover, industry-wide price indices avoid washing out relative price changes that stem from sector-specific quality improvements. However, in the case of Brazil mainly two practical concerns tend to wipe out the benefits of industry-wide price indices. At times of high inflation, the Brazilian federal government imposes price controls in various sectors that are more easily

controlled or more prominent in consumers' minds, while it leaves other (usually the less concentrated) sectors unrestricted. As a consequence, not all prices keep pace with the growth of money supply and price distortions across sectors arise. Similarly, regional and sector-specific conditions (such as contract types, the concentration of industry, and the like) make the price adjustment to inflation less flexible in some sectors or regions, while it is more rapid and adequate elsewhere. These rather monetary factors are likely to distort price differences more strongly than real factors (such as quality, demand, or supply changes, say). As a consequence, sector-specific price indices seem more appropriate than industry-wide indices.

As a general conclusion, a sensitivity analysis with respect to differently deflated data seems key whenever working with *PIA* before 1994. Only a sensitivity analysis is likely to provide an adequate robustness check for the reliability of statistics and estimates, and an assessment of likely distortions through high inflation.

Useful industry-wide price indices are *IPA-OG* (*Índice de Preços por Atacado–Oferta Global*, wholesale price index covering the entire economy including imports; by *FGV*), *IPA-INDTOT* (*Índice de Preços por Atacado–Total da Indústria*, covering all industrial sectors; by *FGV*), *IPA-TRANSF* (*Índice de Preços por Atacado–Transformação*, covering manufacturing sectors; by *FGV*), *IGP-DI* (*Índice Geral de Preços–Disponibilidade Interna*, consumer price index covering domestically produced commodities and services; by *FGV*), and *INPC* (*Índice Nacional de Preços ao Consumidor*, national consumer price index; by *IBGE*).

Some sector-specific wholesale price indices are available for Brazilian manufacturing sectors between 1986 and 1998. The two most natural choices seem to be *IPA-OG* (*Índice de Preços por Atacado–Oferta Global*) and *IPA-DI* (*Índice de Preços por Atacado–Disponibilidade Interna*). Both series are calculated and published by *Fundação Getúlio Vargas (FGV), Rio de Janeiro.* They are wholesale price indices. Brazil disposes of no producer price index for the period 1986-1998. While *IPA-DI* restricts attention to the wholesale of domestically manufactured products, *IPA-OG* includes both imported and domestic goods.

Industry-wide price indices permit deflating all variables in the same manner. As soon as sector-specific indices are indicated, however, different flow variables have to be deflated using different indices. Appropriate choices for different types of flow variables are discussed in the following subsections.

4.3 Price indices for output variables

Being wholesale price indices, neither *IPA-OG* nor *IPA-DI* reflect the price level at the sales gate of the manufacturers. Still, these series seem to come close to proper sector-specific output deflators in Brazil. Neither *IPA-OG* nor *IPA-DI* use sector definitions that coincide with the sector classification in *PIA*. Firms in *PIA* are categorized according to *IBGE*'s *nível 100* system (its degree of detail corresponds roughly to three *SIC* digits). Tables in appendix A (p. 55) propose how to make the

sectoral classifications conform. There are 62 industrial sectors within *nível 100*.

I apply these price indices to the output related variables `grssales`, `sales`, `difstock`, and `resales` in *PIA*.

4.4 Price indices for inputs of domestic intermediate goods

While wholesale price indices may provide adequate series for deflating output, they seem arguably less appropriate for the prices at the firm's gate for purchases. Prices at the input side and at the output side of firms are likely to behave differently in periods of high or volatile inflation. Therefore, I use the national input-output matrices to derive the typical input basket of a firm in a given sector. With this information at hand, sector-specific input price indices are constructed.

The national accounting department at *IBGE* calculates yearly input-output matrices. With the change in the system of national accounts after the 1990 census, however, time-consistent matrices are only available for the years 1990 to 1998, and for 1985. The year 1985 is used to link the 1990 accounting standard to earlier systems. In order to obtain comparable input-output matrices for the entire period 1986-1998, I construct the matrices for 1986 through 1989 as intermediate matrices between the two known matrices for 1985 and 1990. A linear interpolation is applied.

The input-output matrices under the 1990 system are 80×43 matrices—the 80 rows representing the economy-wide sectors at *nível 80* from where the inputs come, and the 43 columns representing the sectors according to *nível 50* to which the inputs go.[5] For the purpose of deflating variables in *PIA*, not quite as many rows and columns (sectors) are needed. Among the 80 rows at *nível 80*, only 52 correspond to industrial sectors. Similarly, among the 43 columns at *nível 50*, only 30 correspond to industrial sectors. I use the reduced 52 by 30 matrices for the calculations to follow. This reduction disregards non-industrial inputs but non-industrial inputs are only a negligible share of total inputs in manufacturing.

For the construction of sector-specific input price indices, only relative weights of those sectors are needed where inputs come from. Due to the form of the input-output matrices, it is the columns which provide these weights. To obtain them, I express the entry in each cell of the input-output matrix as a fraction of the sum of the entries in the respective column. An example is given below.

$$\mathbf{X} = \begin{pmatrix} 100 & 300 & 0 \\ 100 & 200 & 0 \\ 100 & 500 & 100 \\ 100 & 0 & 0 \end{pmatrix} \rightarrow \mathbf{A} = \begin{pmatrix} .25 & .3 & 0 \\ .25 & .2 & 0 \\ .25 & .5 & 1 \\ .25 & 0 & 0 \end{pmatrix}$$

In general, take the input-output matrix $\mathbf{X}$ and call the entry in row i and column j x_{ij}. I obtain the matrix of weights $\mathbf{A}$ by placing the entry $a_{ij} = x_{ij}/(\sum_i x_{ij})$ in

[5] *Nível 50* is equivalent to *atividade 80* and *atividade 100*. It coincides with the first two digits of both *nível 80* and *nível 100* and roughly corresponds to two *SIC* digits.

cell (ij) and linearly construct substitutes for the missing input-output matrices between 1986 and 1989. Call every entry in the weights matrix in 1985 a_{ij}^{85} and call every entry in the 1990 weights matrix a_{ij}^{90}. The intermediate weights for the years $t = 86, 87, 88, 89$ are

$$a_{ij}^{t} = a_{ij}^{85} + (t - 85) \cdot \frac{a_{ij}^{90} - a_{ij}^{85}}{5}. \tag{3}$$

This procedure yields weights matrices for 1986 through 1989 whose columns sum to 1 (since $\sum_i (a_{ij}^{90} - a_{ij}^{85}) = 0$ and $\sum_i a_{ij}^{90} = 1$). Their values linearly reflect the change in the input-output structure over the five-year period.[6]

Finally, call the vector of output price indices for month m in year t $\pi_{output}^{m,t}$. I obtain the vector of sector-specific input price indices as

$$\pi_{input}^{m,t} = (\mathbf{A}^t)' \pi_{output}^{m,t}. \tag{4}$$

For the deflation of data in *PIA*, I depart from the (wholesale) price indices as described in subsection 4.3 above. Then the vectors $\pi_{output}^{m,t}$ represent the 62 industrial sectors at *nível 100*. To make these 62 sectors conform to the 52 industrial sectors at *nível 80*, the price indices need to be averaged at *nível 50*, and $\pi_{output}^{m,t}$ is accordingly reduced to 52 rows. (Where ever possible, finer matches between *nível 80* and *nível 100* are chosen.) The weights matrix $\mathbf{A}^t$ has dimensions 52×30. So, the resulting input price vector $\pi_{input}^{m,t}$ has 30 rows—representing the 30 industrial sectors at *nível 50*.

I apply these deflators to `intmacq` and `intmdif`. Acquisition of foreign intermediate goods should be treated differently. In fact, the present deflators should only be applied to the share `1 - intfrrat` of total intermediate inputs `intmacq` and `intmdif` that are from domestic sources.

4.5 Price indices and tariff series for inputs of foreign intermediate goods

While the above input price indices may provide adequate series for domestic inputs, they seem arguably less appropriate for the prices of foreign intermediates. Prices of foreign intermediates can deviate from prices of domestic intermediates. So, foreign prices should be used instead to deflate foreign inputs. In addition, import tariffs change strongly over the sample period. Furthermore, these changes are accompanied by considerable fluctuations in the real exchange rate. Not removing these price fluctuations from foreign inputs may introduce unwarranted and uncontrolled correlations in production function and productivity estimation.

[6]The construction of a geometrically evolving series of input-output matrices proves infeasible with common micro-computer capacity. The memory of a typical microcomputer does not suffice to take the fifth root of the 30×30 square matrix $(\mathbf{A}^{85\prime}\mathbf{A}^{85})^{-1}\mathbf{A}^{85\prime}\mathbf{A}^{90}$.

Foreign input price series cannot be inferred from existing Brazilian price indices since the underlying quantity grids are not published. Instead, I construct sector-specific foreign input price indices from baskets of foreign producer and wholesale price index series for Brazil's major 25 trading partners. I then translate these price index series into domestic prices using the nominal USD exchange rate and adjust for the prevailing tariff rate. The resulting index series are adequate deflators for foreign intermediate inputs.

I start by constructing sector-specific foreign price indices that correspond to Brazilian manufacturing sectors. The focus lies on producer price indices as they reflect foreign producer costs most closely. However, for important Brazilian trading partners who do not publish producer price indices I use their wholesale and consumer price indices instead. I construct the foreign price series in four steps: (1) Sector-specific producer price indices for OECD countries, (2) aggregate producer, wholesale and consumer price indices for non-OECD countries, (3) import-weighted foreign price series, (4) sector-specific foreign price series for intermediate inputs. For this fourth and final step, I reuse the national input-output matrices to derive the typical input basket of a firm in a given sector. With this information at hand, sector-specific foreign input price indices are inferred as in section 4.4.

4.5.1 Producer price indices for OECD countries

I obtain sector-specific Producer Price Index (PPI) series for these OECD countries over the period 1986-1998 from SourceOECD's *Indicators of Industry and Services*.[7] The US is Brazil's single most important trading partner. I use its more detailed PPI series from the *Bureau of Labor Statistics* to substitute for the aggregate OECD data. The US PPI data span the period 1986-2003.

Sector definitions at the OECD and the US *Bureau of Labor Statistics* only partly coincide with the two most common industry classifications in Brazil: *nível 100* (*nível 80*) and *CNAE*. I document the conversion from OECD sectors to *Nível 100* in Muendler (2003a). Possible conversions from *SIC* (US) to *Nível 100* are discussed in Muendler (2002) in detail.[9] The concordance applied to US PPI series is based on a 'loose' converter that permits some incompatibilities in select sectors to achieve sector matches at finer levels.

4.5.2 Price indices for Brazil's non-OECD trading partners

Global Financial Data (*www.globalfindata.com*) offers annual aggregate producer price, wholesale price and consumer price series for many countries. I obtain ac-

[7]The OECD countries among Brazil's major import sources in 1995 are:[8] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

[9]Both papers available from *www.econ.ucsd.edu/muendler/brazil*.

cording price indices for all non-OECD (and OECD) countries among Brazil's major 25 trading partners (as measured by imports in 1995). I substitute these series whenever PPI series are missing.[10]

4.5.3 Average foreign price series

Based on these raw sector-specific OECD-wide PPI series and annual aggregate PPI-WPI-CPI series, I construct average foreign price series for the group of Brazil's main trading partners. I use Brazil's import shares from those source countries in 1995 as weights. The world-price series for Brazil's main 25 trading partners is a mixture of sector-specific *and* aggregate price indices.

- Monthly sector-specific PPI series are available for the US only (see subsection 4.5.1). The US is Brazil's single largest trading partner and accounts for around a quarter of all Brazilian imports.
- Annual sector-specific PPI series for 11 OECD countries among Brazil's major 25 trading partners are available (see subsection 4.5.1). The annual series are turned into monthly series through linear interpolation.
- Annual aggregate PPI, WPI or CPI series are available for the remaining 13 countries not in the OECD sample but among Brazil's main 25 trading partners in 1995 (see subsection 4.5.2). The annual series are turned into monthly series through linear interpolation.

  The price index P_i^m for any month $m = 1, \ldots, 12$ between July of one year t and June of the following year $t+1$, is calculated as

  $$P_i^{m,t/t+1} = P_i^{\text{July},t} + (m-1) \cdot \frac{P_i^{June,t+1} - P_i^{July,t}}{12}.$$

  In the beginning year of the series posterior-year interpolation is extended to January through June. In the ending year of the series prior-year interpolation is extended to July through December.

The resulting foreign final-goods price indices for Brazil's main 25 trading partners are sector-specific and monthly series. The series are based on a mixture of sector-specific (12 OECD countries) PPI and aggregate (13 non-OECD countries) PPI, WPI, or CPI series.[11]

[10] Annual PPI series are obtained for: Belgium, Canada, France, Germany, Korea, Netherlands, Spain, Sweden, Switzerland, the United Kingdom, and the US. Annual WPI series are obtained for: Argentina, Chile, Italy, Japan, Mexico, Singapore, Taiwan, Uruguay, and Venezuela. Annual CPI series are obtained for: China, Hong Kong, Panama, Paraguay, Saudi Arabia.

[11] The sector-specific PPI of the following 12 OECD countries are covered: Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, United Kingdom, United States. The aggregate PPI, WPI or CPI of the following 13 non-OECD member countries are covered: Argentina, Chile, China, Hong Kong, Korea, Mexico, Panama, Paraguay, Saudi Arabia, Singapore, Taiwan, Uruguay, Venezuela.

4.5.4 Deflators for foreign intermediate inputs

I use the so-obtained foreign final-goods price series to construct foreign input price series. I transform the final-goods price series to input prices using the input-output matrices for 1985, and 1990 through 1998 (as described in section 4.4). This procedure yields the relevant sector-specific input prices for Brazilian mining firms and manufacturers.

Two more treatments are warranted to arrive at the relevant domestic Brazilian prices for foreign intermediate inputs. First, I translate the foreign price series into domestic Brazilian prices using the monthly USD-BRL exchange rate. The US is Brazil's major import source country, typically accounting for about a quarter to a third of Brazilian imports during the 1990s. The US dollar is also the main vehicle currency for Brazil's currency trading. So, the USD-BRL exchange rate appears to be a fair proxy to the prevailing exchange rates for importers in Brazil.

Second, I augment the BRL-transformed foreign price series by the prevailing average annual tariff rates for sector-specific inputs. For this purpose, I use the monthly final-goods *ad-valorem* tariffs and transform them in the same way as described in section 4.4 for final-goods prices. The inclusion of tariff levels in the foreign price series is based on the assertion that firms acquire foreign intermediates whenever they expect cost savings or quality improvements in production to compensate for higher price. Removing the tariff induces firms to more foreign intermediate-goods acquisitions under the additional assertion that world markets are perfectly competitive. A tariff removal would not necessarily affect the foreign input choice if a single foreign monopolist extracted all rents from buyers through price.

I re-base the foreign intermediate input price series to August 1994 *after* applying the nominal exchange rate and tariff transformations. The successful anti-inflation plan *Plano Real* brought the BRL to a nominal parity with the USD in August 1994, calculated at purchasing power parity. In addition, the vast majority of tariffs attained the lowest levels in the sample period at the end of 1994 or the beginning of 1995, before rising again. This makes August 1994 the natural base month. As a consequence of this procedure, the exchange rate levels and the *ad-valorem* tariff levels of August 1994 become the joint baseline levels. A foreign intermediate good purchased for BRL 1 is equally valuable in real terms as a domestic intermediate good purchased for BRL 1 in August 1994, but in no other month.

I apply these deflators to foreign intermediate inputs, which can be calculated as the share `intfrrat` of total intermediate inputs `intmacq`.

4.6 Price indices for inputs other than intermediate goods

Under inflation, economic variables such as salaries, financial expenditures and rental or leasing rates tend to respond more or less in line with money supply. Accordingly,

they are often deflated by economy-wide consumer price indices such as *INPC* or *IGP-DI*. However, in the context of a firm's decision making process, the use of a less general deflator may be more appropriate. For the firm, its decision to substitute between factors of input (capital and labor, say) or between different forms of employing these factors (make or buy or rent) depends on the relative prices of these alternatives, and the relative sales price for final products. Therefore, a more adequate choice may be the use of sector-specific rather than economy-wide price indices. In particular, the use of the *IPA-OG* and *IPA-DI* series for deflating outputs and intermediate goods inputs suggest the use of the industry-wide prices indices within the *IPA-OG* or *IGP-DI* series, too, to deflate the above-mentioned economic variables. The appropriate choice of a deflator for `profit` is less clear. However, since balance sheet profits also serve as an indicator for the management's evaluation of a firm's success and since profits derive from industry-specific activity, the use of indices such as *IPA-OG* or *IGP-DI* may again be most adequate.

I apply these price indices to the variables `wagetop`, `wagewh`, `wagebl`, `asrtimmo`, `aslsimmo`, `fincost`, and `profit` in *PIA*. Depreciation costs `deprec` are treated like total asset retirements `asltot` (see section 5.4).

4.7 Price indices for acquisitions of domestic capital goods

There are six main groups of gross investment flows in both *PIA velha* and *PIA nova*: (1) buildings, (2) machinery, (3) vehicles, (4) computers, (5) other investment goods, and (6) total investment flows. This section discusses asset purchases in these six categories (gross investment flows). Asset retirements need to be treated differently and are discussed in section 5.4 below. For the groups (2) through (5), appropriate price indices are constructed using the average of adequate sector-specific (wholesale) price indices. Table 13 shows the sectors over which the according price indices are averaged. The weights for the averages are obtained from the national capital formation vector for Brazil, which is explained below. (For this purpose the finest possible matches between *nível 80* and *nível 100* are chosen.)

Deflating total gross investment (group (6)) is more intricate. If the national accounts in Brazil provided sector-specific capital formation statistics, investment flows could be deflated by indices similar to the ones constructed for intermediate goods (in subsections 4.4 and 4.5). However, for the period until 1998 *IBGE* does not break capital formation down into sectors. Instead of a capital formation matrix, *IBGE* only provides a capital formation vector for the economy as a whole, containing the sectors whose output is used for capital formation. I use the (normalized) entries in this capital formation vector as weights for a price index to deflate total gross investment, and as the weights for groups (2) through (5). The capital formation vector is based on the industry classification at *nível 80*. Capital formation vectors between 1986 and 1989 are missing. They are constructed through linear interpolation. Calling an entry in the capital formation vector in 1985 a_{ij}^{85} and an

Table 13: Price Indices for Gross Investment Flows

Group	Name	Sectors (*nível 80*)[a]
1	`buildings`	(general index)
2	`machinery`	801, 1101
3	`vehicles`	802, 1201, 1301
4	`computers`	1001[b]
5	`other`	1401, 3201
6	`total`	(capital formation weights)

[a]For a list of sectors at *nível 80*, see appendix A.5.
[b]Only uses sector 1030 at *nível 100*.

entry in the 1990 vector a_{ij}^{90}, the intermediate entries for the years $t = 86, 87, 88, 89$ result as

$$a_{ij}^{t} = a_{ij}^{85} + (t - 85) \cdot \frac{a_{ij}^{90} - a_{ij}^{85}}{5}.$$

This procedure yields proper weights for 1986 through 1989, and their values linearly reflect the change in the capital formation structure over the five-year period.

Call the vector of output price indices for month m in year t $\pi_{output}^{m,t}$. Call the vector of weights, derived from the capital formation vector, $\mathbf{a}^t$. I then obtain the economy-wide gross investment flow deflator as

$$\pi_{investment}^{m,t} = (\mathbf{a}^t)' \pi_{output}^{m,t}, \tag{5}$$

a scalar. In the case of *PIA*, I depart from the (wholesale) price indices as described in subsection 4.3 above. Then the vectors $\pi_{output}^{m,t}$ represent the 62 industrial sectors at *nível 100*. To make these 62 sectors conform to the 52 industrial sectors at *nível 80*, the price indices need to be averaged at *nível 50* (or the finest possible mapping above), and $\pi_{output}^{m,t}$ is accordingly reduced to 52 rows. The weights vector $\mathbf{a}^t$ has 52 rows.

I apply the group (2) price index to the variables `acqmasum`, `acqmadom`, `acqmause`. I do not apply the group (2) index to `acqmafor` but use a foreign machinery price index series instead (as described in the following section 4.8). The group (3) price index is applied to `acqveh`, the group (4) index to `acqcomp`, and the group (5) index to `acqother`. The group (6) index seems most appropriate for `acqtot` and possibly `acqbl`. However, I deflate `acqbl` in group (1) with the general price index *IPA-DI* (or *IGP-OG*). Alternatively, a construction price index series could be used.

4.8 Price indices for acquisitions of foreign capital goods

In the case of machinery, *PIA velha* explicitly separates foreign machinery acquisitions from acquisitions of domestic (and used) machinery.

While the above price indices may provide adequate series for domestic capital goods, they seem arguably less appropriate for the prices of foreign capital goods. Prices of foreign capital goods deviate from prices of their domestic counterparts. So, foreign prices should be used instead to deflate foreign capital goods. In addition, import tariffs change strongly over the sample period. Furthermore, these changes are accompanied by considerable fluctuations in the real exchange rate. Not removing these price fluctuations from foreign capital-goods prices may introduce unwarranted and uncontrolled correlations in production function and productivity estimation.

Foreign capital-goods price series cannot be inferred from existing Brazilian price indices since the underlying quantity grids are not published. Instead, I construct economy-wide foreign capital-goods price indices from baskets of foreign producer and wholesale price index series for Brazil's major 25 trading partners. I then translate these price index series into domestic prices using the nominal USD exchange rate and adjust for the prevailing tariff rate. The resulting index series are adequate deflators for foreign capital goods.

I start by constructing sector-specific foreign price indices that correspond to Brazilian manufacturing sectors. The focus lies on producer price indices as they reflect foreign producer costs most closely. However, for important Brazilian trading partners who do not publish producer price indices I use their wholesale and consumer price indices instead. I construct the foreign price series in four steps: (1) Sector-specific producer price indices for OECD countries as described in subsection 4.5.1 above, (2) aggregate producer, wholesale and consumer price indices for non-OECD countries as described in subsection 4.5.2 above, (3) import-weighted foreign price series as described in subsection 4.5.3 above. (4) I obtain economy-wide foreign price series for capital-goods in the following manner.

I use the foreign final-goods price series from steps (1) through (3) to obtain economy-wide and annual foreign capital-goods price series. Subsequently, I follow the procedures of section 4.7 again, now applying them to foreign rather than domestic capital-goods prices. I obtain foreign price index series for the five groups of gross investment flows in table 13—on the basis of an import-weighted mix of sector-specific and aggregate PPI, WPI and CPI foreign price series of Brazil's major 25 trading partners.

Two more treatments are warranted to arrive at the relevant domestic Brazilian prices for foreign intermediate inputs. First, I translate the foreign price series into domestic Brazilian prices using the monthly USD-BRL exchange rate. The US is Brazil's major import source country, typically accounting for about a quarter to a third of Brazilian imports during the 1990s. The US dollar is also the main vehicle currency for Brazil's currency trading. So, the USD-BRL exchange rate appears to be a fair proxy to the prevailing exchange rates for importers in Brazil.

Second, I augment the BRL-transformed foreign price series by the prevailing average annual tariff rates for sector-specific inputs. For this purpose, I use the

monthly final-goods *ad-valorem* tariffs and transform them in the same way as described in section 4.4 for final-goods prices. The inclusion of tariff levels in the foreign price series is based on the assertion that firms acquire foreign capital goods whenever they expect cost savings or quality improvements in production to compensate for higher price. Removing the tariff induces firms to more foreign capital-goods acquisitions under the additional assertion that world markets are perfectly competitive. A tariff removal would not necessarily affect the foreign input choice if a single foreign monopolist extracted all rents from buyers through price.

I re-base the foreign capital-goods price series to August 1994 *after* applying the nominal exchange rate and tariff transformations. The successful anti-inflation plan *Plano Real* brought the BRL to a nominal parity with the USD in August 1994, calculated at purchasing power parity. In addition, the vast majority of tariffs attained the lowest levels in the sample period at the end of 1994 or the beginning of 1995, before rising again. This makes August 1994 the natural base month. As a consequence of this procedure, the exchange rate levels and the *ad-valorem* tariff levels of August 1994 become the joint baseline levels. A foreign capital good purchased for BRL 1 is equally valuable in real terms as a domestic capital good purchased for BRL 1 in August 1994, but in no other month.

I apply these deflators to foreign machinery acquisitions `acqmafor`.

5 Deflating Assets and the Construction of Capital Stock Series

As mentioned in the preceding section 4, *Legislação Societária* mandates that firms correct the values of their assets in the balance sheet every year. It further requires that they do this correction on the basis of a governmentally administered price index. *PIA* requests that firms report all variables according to this law. The official price index generally tends to understate true inflation. This creates a first bias in the reported stock variables in *PIA*. The bias becomes sizeable over the years. In 1991, the federal government allows firms a once-and-for-all correction of this bias. *Lei n. 8200 de 28-6-91* and the according order *Decreto n. 332 de 4-11-91* to enforce it give all firms the option to revalue their capital stock between January 1991 and December 1991 (Rodrigues, Pereira da Silva and Barros 1992). Firms have strong incentives to revalue their capital stock since they can increase the value of their assets without being taxed for it, and will be allowed to claim the increased depreciation cost in their income statements from 1993 on, thus lowering profits and corporate taxes. *PIA* does not allow to directly observe which firm opts for the correction of the capital stock. These facts make it difficult to construct a capital stock series from balance sheet data. However, there are reasonably precise ways to correct for the two possible biases.

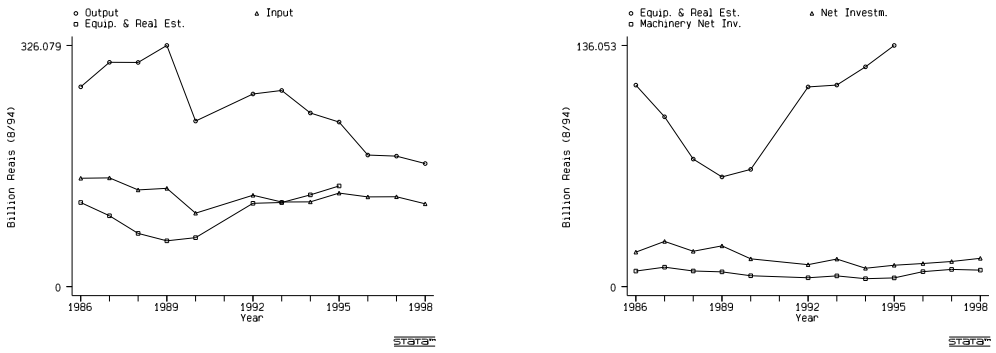
Constructing a capital stock series from net investment flows (using a perpetual inventory method, say), is not safe from these two biases either. The reason is that asset retirements in *PIA* are recorded with the remaining book values at the time of the asset retirement.[12] So, whereas gross investments are properly deflated using price indices as described in subsections 4.7 and 4.8, the asset retirements counterpart is most likely not deflated correctly with these indices. As a consequence, net investment flows can only be properly inferred when remaining book values are known.

All price index, tariff, exchange rate and interest rate series mentioned in the present section can be downloaded from *www.econ.ucsd.edu/muendler/brazil*.

5.1 Judging consistent capital stock series

Figure 2 shows two series of relevant economic variables in *PIA*. While the flow series are deflated as described in the preceding section 4, the asset series are treated as if none of the aforementioned potential pitfalls existed. The reported year-end values in *PIA* are merely adjusted to a common base month (August 1994). I will subsequently call this series the raw series. Compared with output and value added fluctuations, changes in the capital stock may even seem moderate. The

[12]Following Brazilian accounting principles, a possible difference between the sales prices for a retired machine and the book value enters the profit or loss account as extra-ordinary revenue of cost.



Data: Unbalanced panel of all firms in *PIA* 1986-1998. Figures are unweighted sums.

Figure 2: Value added, net investment, and the raw capital series

capital stock is measured as the total of ground and premises, machinery, vehicles, and other equipment (`aspimmo`, for *Ativo Imobilizado*). However, when taking the net investment flows both for the *Ativo Imobilizado* (`acqtot` and `asltot`) and just for the machinery part within the *Ativo Imobilizado* (`acqmasum` and `aslmasum`), their fluctuation cannot explain the change in the capital stock—unless there is a negative depreciation rate in 1992. There are mainly two peculiarities about the series. First, the capital stock falls between 1986 and 1988 while net investment flows remain constant. This could be explained by a changing depreciation rate that was higher before the modernization of the capital stock in the late eighties, and possibly by high capacity utilization, wearing the capital stock out. Second, the capital stock jumps in 1992. This is entirely unexplicable with the other data series. Unless there is a huge unobserved jump in investment in 1991 (the missing year in *PIA*), which is unlikely given the general economic situation in Brazil that year, investment flows are at odds with an increase in the stock in 1992. This jump is most likely a consequence of the optional asset revaluation in 1991.

Given the fact that both net investment flow and capital stock series are constructed in *PIA*, I play one against the other until I find two mutually consistent series. An immediate criterion for consistency is, for instance, that the implicit depreciation rate behind the two series must not turn negative in any year. The missing year 1991 makes it difficult but not impossible to design algorithms based on several criteria such as: 'no negative implicit depreciation rate', 'no increases or decreases of more than x per cent in any two consecutive years', and are extended to criteria such as 'abnormally high implicit depreciation rates only in years with high capacity utilization', and so forth. It is straightforward to confirm that the data series depicted in figure 2 violate several reasonable criteria.

In subsections 5.3 and 5.4 below, I elaborate a method to measure the potential bias in book values of assets and assets sales, respectively. However, after applying the measures to *PIA*, the resulting capital stock and investment flow series do not meet several other consistency criteria. While the re-valuation jump in 1992 will disappear, intermediate capital stock values in 1989 and 1990 start to violate consistency. Subsection 5.7 will finally describe a method to correct the capital stock series in a way that satisfies reasonable consistency criteria. To start, the following section briefly describes the series of governmentally administered price indices by which assets have to be valued.

5.2 Governmentally administered deflators

A recast of the governmentally administered official price index makes part of almost every Brazilian plan to combat inflation until 1994. Several of these indices deliberately underestimate true inflation. Between January 1986 and December 1994, the combined series of official price indices reports an average annual inflation rate of around 710 per cent. True inflation is about 820 per cent (as measured by *IBGE*'s *INPC*). The according indices since 1964 are:

- *ORTN* (*Obrigação Reajustável do Tesouro Nacional*) in force from October 1964 until January 1989, renamed to *OTN* (*Obrigação do Tesouro Nacional*) under *Plano Cruzado* in 1986 (*Decreto-lei n. 2284/86*). There are two series for the year 1986, one applicable to assets (frozen between March 1986 and February 1987) and the other applicable to asset retirements (continuously adjusted every month).

- *BTN* (*Bônus do Tesouro Nacional*) in force from February 1989 until January 1991 (*Lei n. 7777/89*).

- *FAP* (*Fator de Atualização Patrimonial*) in force for the months February until December 1991 (*Decreto n. 332 de 4-11-91* retroactively).

- *UFIR* (*Unidade Fiscal de Referência*) in force since January 1992. For the period January 1992 through August 1994, daily values are provided (*UFIR Diária*, *Lei n. 8383/91*); beginning-of-month values are generally to be used for deflating monthly figures. For the period September until December 1994, monthly values are provided (*UFIR mensal*, *lei 9069/95* retroactively). Quarterly values of *UFIR* are calculated from January 1995 on, half-year values from January 1996 on, and since January 1997 yearly values (*lei 9069/95*) are provided. (*UFIR* will finally be repealed in October 2000.)

I combine these official price indices to two consistent monthly series of governmentally administered price indices. Due to a different treatment in 1986, one series has to be applied to assets (`govdefl-asset`), and another series to asset retirements

(`govdefl-decap`). The proper links of the indices over time are documented in IOB (2000), for example.

5.3 Stock variables

Suppose the capital stock of a firm (or, for the present purpose, one asset position in the balance sheet) is composed of many different single units $i = 1, \ldots, N$. The value of each unit i at the date of purchase $t_0(i)$ is $k_i(t_0(i))$. For simplicity, call it k_i. This unit i wears out and depreciates, and its value needs to be adjusted for inflation. A firm thus calculates the total value of its capital stock (or a position in its balance sheet) at time t using a formula like

$$K_t = \sum_{i=1}^{N} \frac{\pi_t}{\pi_{t_0(i)}} \cdot \delta_{t,i} \cdot k_i, \tag{6}$$

where total depreciation of each unit at time t is given by $\delta_{t,i} \equiv \prod_{s=t_0(i)}^{t} \delta_s$. The main issue is the application of an adequate price index π_s at times $s = t$ and $s = t_0(i)$.

By law, firms are forced to use the governmentally administered price index (*ORTN* through *UFIR*), which understates inflation. Call this price index π_s^{otn}. It underlies the asset value $\widetilde{K}_t$ reported in *PIA*. So, the true value of the capital stock exceeds the reported value of the capital stock by a factor of

$$\frac{K_t}{\widetilde{K}_t} = \frac{\sum_{i=1}^{N} \frac{\pi_t}{\pi_{t_0(i)}} \delta_{t,i}\, k_i}{\sum_{i=1}^{N} \frac{\pi_t^{otn}}{\pi_{t_0(i)}^{otn}} \delta_{t,i}\, k_i} = \frac{\pi_t}{\pi_t^{otn}} \frac{\sum_{i=1}^{N} \frac{1}{\pi_{t_0(i)}} \delta_{t,i}\, k_i}{\sum_{i=1}^{N} \frac{1}{\pi_{t_0(i)^{otn}}} \delta_{t,i}\, k_i}. \tag{7}$$

This factor is equal to unity if both the true and the imposed price index series are the same at all times. If, on the other side, the imposed price index falls short of the true price index in every period t except for one initial period $t_0(i)$ at which, suppose, all assets have been purchased, the factor takes a value of π_t/π_t^{otn}.

The remaining task is to find a reasonable value for factor (7) that is not comprised by too strong assumptions. The procedure proposed here is based on three assumptions. Assumption (a): All firms apply a linear depreciation method. This method equally distributes the initial value of the asset over the years of its likely use. In practice, a large number of Brazilian firms applies this linear depreciation for most assets. Assumption (b): The average life-time of an asset is given by the third column in table 14. Assumption (c): Every position in the balance sheet is composed of a number of units N. It is equally likely that any one of these N units is acquired in January, February, or any other month of a given year.

The alleged lifetimes under assumption (b) may seem low when contrasted with comparable geometric depreciation rates. For a comparison, the fourth and fifth column in table 14 list the corresponding values for an annual depreciation rate δ

Table 14: Lifetime of Assets by Brazilian Accounting Standards

Group	Name	Lifetime z in years[a]	Deprec. Rate δ down to 10%	Deprec. Rate δ down to 5%
1	`buildings`	25	.088	.113
2	`machinery`	10	.206	.259
3	`vehicles`	5	.369	.451
4	`computers`	4	.438	.527

[a]These rule-of-thumb lifetimes apply particularly to electrical equipment and electronics manufacturing. They are not expected to differ in similar sectors, but may differ to some degree for industries such as chemicals and pharmaceuticals.

if geometric depreciation is applied and if the asset still has 10% or 5% of its value at the end of the lifetime. To my knowledge, there are no precise estimates for capital depreciation in Brazil as of today. Even if such measures exist, it seems more adequate to neglect them and to use the typical choices of asset lifetimes made by Brazilian accountants, instead. After all, I am interested in correcting typically employed accounting methods retroactively.

It is difficult to judge how strong (and possibly wrong) assumption (c) is in practice. In general, the less frequently an asset is purchased or improved, or the lower its turnover, the more misleading is assumption (c). However, the lifetime of an asset may not be very indicative of whether assumption (c) is too strong for the asset or not. Even though buildings and machinery are purchased at distant intervals, they are also continuously renewed through appropriate services, overhauls, and renovation work. By Brazilian accounting standards, this increases their value again. Similarly, if a firm is large it is likely that the capital stock in different units of operation is replaced with new equipment at different times. This smoothes out possible errors from assumption (c).

Assumption (a) implies that the geometric depreciation term $\delta_{t,i}k_i$ in (6) and (7) needs to be replaced appropriately. Take computers as an example. Every computer, no matter when purchased, is supposed to remain in use for four years by assumption (a). Assumptions (b) and (c) then imply, for any given point in time, that one quarter of the computer stock is between 37 and 48 months old, one quarter between 25 and 36 months, and so fourth. Or, more precisely, the oldest 48^{th} of the computer stock has only one 48^{th} of its lifetime to survive, the second-oldest 48^{th} will remain in use for two more 48^{th}s of its lifetime, and so on. So, I can assign a weight to every 48^{th} of the capital stock, the oldest receiving a weight of 1 and the youngest a weight of 48. These weights sum up to $(1 + 48) \cdot (48/2) = 1,176$.

More generally, I can call each of these weights σ_m, representing the bundle of units ($i(m)$) that are acquired in month m. For a capital good with a lifetime of z

years, there are $12z$ months of use. Thus,

$$\sigma_m \equiv \frac{m}{(1+12z)6z},$$

where $m = 1, \ldots, 12z$. Hence, the formula in (7) can be rewritten to

$$\frac{K_t}{\widetilde{K}_t} = \frac{\sum_{m=1}^{12z} \frac{\pi_{12z}}{\pi_m} \sigma_m}{\sum_{m=1}^{12z} \frac{\pi_{12z}^{otn}}{\pi_m^{otn}} \sigma_m} = \frac{\sum_{m=1}^{12z} \frac{\pi_{12z}}{\pi_m} m}{\sum_{m=1}^{12z} \frac{\pi_{12z}^{otn}}{\pi_m^{otn}} m}. \tag{8}$$

In this notation, $12z$ represents December of the respective year in *PIA*. Formula (8) is a backward looking expression and specific to each type of capital good (it depends on z, which differs for different capital goods). In this formula, the backward horizon lies the further in the past the longer a typical unit of capital is supposed to be in use.

This method is applied to `aspimmo`, `aspdefer`, and `aspmasum`. Some liability variables and some further asset variables are also deflated with this method.

5.4 Asset retirements

Asset retirements in *PIA* are adjusted in a manner similar to the correction of capital stock values. Call the asset retirements in a given year t S_t. Then, similar to equation (6),

$$S_t = \sum_{j=1}^{M} \frac{\pi_t}{\pi_{t_0(j)}} \cdot \delta_{t,j} \cdot k_j^s, \tag{9}$$

where k_j^s now denotes capital good j, which is acquired at $t_0(j)$ and is being sold at time t. Call the observed figure of asset retirements in *PIA* $\widetilde{S}_t$.

Under the same assumptions (a) through (c) as made for capital stock variables in subsection 5.3 above, the adjustment factor for asset retirements becomes

$$\frac{S_t}{\widetilde{S}_t} = \frac{\sum_{m=1}^{12z} \frac{\pi_{12z}}{\pi_m} m}{\sum_{m=1}^{12z} \frac{\pi_{12z}^{otn}}{\pi_m^{otn}} m}. \tag{10}$$

Assumption (c) is a little more restrictive in this context. Assumption (c) states that each asset sold today is equally likely to have been acquired in any preceding month. It seems more probable, however, that old capital goods are sold more often than recently purchased ones. There are possible adjustments to formula (10) such as replacing the factor m in both the numerator and the denominator by a less steeply increasing function of m. However, these adjustments seem as arbitrary as leaving the formula in this form. However, the factor (10) can be biased. The

direction of the bias depends on the differences in inflation between more recent periods and more distant periods in the past. If inflation rates are very high in the distant past but lower lately, factor (10) tends to be too low and to understate the necessary correction. Similarly, if inflation rates are comparatively low in the distant past and higher lately, factor (10) tends to be too high and to overestimate the necessary correction.

This method is applied to variables `asltot`, `aslbl`, `aslmasum`, `aslveh`, `aslother`, `aslcomp`, and `deprec`, the annual total depreciation cost.

5.5 Optional revaluation of assets in 1991

A change in Brazilian tax law in 1991 allows firms to revalue their assets in the balance sheet and to correct the bias that the governmentally administered price index have caused over the years. It is highly likely that many firms opt for this possibility in 1991. The value increase is not taxed but higher depreciation rates in the future will reduce taxable profits. To my knowledge, there are no statistics that would allow to infer which firms choose to revalue in 1991 and which do not. After 1991, the government requires again that firms adjust their asset values on the basis of the official price index, which continues to understate inflation.

So, the observed asset values in *PIA* between 1992 and 1994 suffer from a downward bias again. However, this bias is weakened for all firms that choose to revalue in 1991. Assets of revaluing firms have the right value in 1991 and suffer from a lack of correction only thereafter. Hence, formulas (8) and (10) need to be modified in the case of those firms. For any month prior to January 1992, the ratios $\pi_t/\pi_{t_0(i)}$ in the numerator and denominator need to be replaced. I replace them with the value that they take in December 1991, the date at which revaluation allows to make all asset values precise. In the case of non-revaluing firms, on the other side, assets and asset retirements are still correctly valued by formulas (8) and (10).

How, then, can one arrive at proper asset values after 1991? There are two types of assumptions one can make. Assumption (i): Almost every firm in *PIA* revalues in 1991, and the few firms that do not revalue have little to correct. *PIA velha*'s firms are medium-sized to large manufacturers, and certainly have the resources to undertake a revaluation of their assets. In addition, most Brazilian firms keep more than one book—one of them being for internal use and more accurate. So, the necessary information is already available to these firms. Moreover, the prospect of tax savings is a strong incentive for them to show the revaluation in their balance sheet. Finally, the few firms in *PIA* that choose not to revalue in 1991 do not expect big tax savings, that is, they expect only small corrections in value. Thus, under this assumption, I commit hardly any error by considering all firms as having effectively revalued. It also seems a likely scenario, and thus safe to adopt.

Assumption (ii): Only a share of firms in *PIA* revalues, accounting cost do not outweigh tax savings. This seems the less likely scenario. Yet, one may find

Table 15: Correction Factors for Asset Figures

	Group	Lifetime	*IPA-OG* (at *nível 80*)[a]	*IPA-DI*[b]
1	`buildings`	25	(general index)	ipadi (or igpdi)
2	`machinery`	10	801, 1101	maq
3	`vehicles`	5	802, 1201, 1301	veiculos[c]
4	`computers`	4	1001[d]	bcd-ud
5	`other`	6[e]	1401, 3201	ipadi
6	`total`	14[f]	(capital formation)	ipadi

[a]For a list of sectors at *nível 80*, see appendix A.5. Weights according to annual capital formation vector.

[b]For the definition of abbreviations see appendix A.3.

[c]Series for *trans* are only available after 1986 and thus not applicable.

[d]Only uses sector 1030 at *nível 100*.

[e]Hypothesized value.

[f]Inferred from typical capital stock composition in *PIA*.

it worthwhile to program algorithms that identify potential 'revaluers.' For this purpose, the 1990 capital stock could be extrapolated, and average net investment flows could be used to identify firms whose jump in the capital stock in 1992 relative to the extrapolated value implies too low a depreciation rate. However, there are two drawbacks to this method. First, the year 1991 is missing in *PIA* and any extrapolation over two years, from 1990 to 1992, will be vague. Second, the threshold for 'too high a jump' (or 'too low an implicit depreciation rate') is arbitrary. When one then corrects the capital stock of the jumpers, one likely reduces the correction factor (8) by the size of the threshold. So, the method risks to become circular. Thus, who considers assumption (ii) the more likely scenario should be cautioned from using capital stock series in *PIA* at all. There may not be useful statistical means to correct for the problems arising from the assumption.

5.6 Correction factors for asset figures

The key terms in both formula (8) and (10) are the ratios π_{12z}/π_m and $\pi^{otn}_{12z}/\pi^{otn}_m$. They are correction factors to undo valuation errors retroactively. In a notation closer to the initial one, they could also be written as π_t/π_m and π^{otn}_t/π^{otn}_m. Here t corresponds to December of the respective year in *PIA* $(86, \ldots, 98)$, and m denotes any month in the $4, 5, 10$, or 25 years preceding t. The correction method proceeds in two steps.

First, for every year in *PIA* the correction factors π_t/π_m and π^{otn}_t/π^{otn}_m are derived. There are six groups of capital goods for which they need to be constructed as shown in table 13. Table 14 lists the four groups for which accounting assumptions on

lifetime are typically made.[13] I use average price indices in the case of groups (2) through (5) as indicated in table 15, while a construction price index or a general price index such as *IGP-DI* or *IPA-DI* seem most appropriate for buildings (1).

The underlying price indices for buildings would need to range back until 1961. However, even the governmentally administered price index *ORTN* only dates back to October 1964. For all present purposes January 1965 is used as first available month. The ratios π_t^{otn}/π_m^{otn} are set equal to the oldest available observation before that date. Similarly, the ratios π_t/π_m are set to the January 1969 value for years before 1969 when *IPA-OG* and *IPA-DI* are used. Finally, the price index *INPC* (possibly useful for buildings) is only calculated since March 1979. For the preceding months and years, it seems most adequate to use the historic price index series *IGPC-MTb* (*Índice Geral de Preços ao Consumidor-Ministério do Trabalho*), a national consumer price index provided by the Brazilian federal labor ministry at the time (IBGE 1990).

The lifetime for other assets is hypothesized and the average lifetime for total assets is inferred from a typical capital stock composition in *PIA*, given the accounting lifetimes for the preceding categories in table 15. I make the following back-of-the-envelope calculation for that purpose.

	Gr. Inv. (86-98)	Cap. Stock (86-90)	Turnover	Lifetime
buildings	25.4 %	34.7 %	0.73	25 years
machinery	48.7 %	48.7 %	1.00	10 years
vehicles	4.1 %	2.4 %	1.75	5 years
computers	1.5 %	0.7 %	2.25	4 years
other	20.4 %	13.7 %	1.49	→ *6 years*
total	→ *12.7 years*	→ *14.5 years*		

While the investment flows are known between 1986 and 1998 for all types of capital goods, stocks are only known from the first part of *PIA velha* between 1986 and 1990. The ratios of flows to stocks indicate that 'other capital goods' exhibit an intermediate turnover between machinery and vehicles. So, six years are hypothesized as their average lifetime. With these numbers at hand, the average lifetime of the total capital stock is between 12 and 15 years. 14 years are used subsequently. The reason for using a value closer to the upper bound is that the book values of land is generally not depreciated. As land is part of the total assets, too, the average lifetime of total assets might be understated when excluding land from the calculation.

[13] As far as pure manufacturing firms are concerned, soil is not exhausted and does not need to be depreciated. In the case of mineral or metal extraction, a further series for `ground` would need to be constructed that applies a weighting scheme different from formulae (8) and (10) to account for the loss in value due to extraction.

The accordingly corrected end-of-year values are still current values. They need to be taken to some common base year. This is done by applying the respective indices in table 15 again. In order to arrive at year-end values, the January and December price indices around the respective year-end are averaged if they are mid-month indices.

Putting this procedure to work yields the capital stock and net investment series shown in figure 3. There are two new peculiarities about the series. First, the correction factors for the years 1989 and 1990 become extremely large, pushing the capital stock in these years even further up then before. There is no movement in either investment flows or output that could justify this jump. The years 1989 and 1990 are two years of extremely high inflation and economic uncertainty. While the first fact pushes the capital stock series up, the second suggests that the method may be particularly wrong in these years. In periods of high uncertainty, turnover of capital goods is low, gross investment will be low, and there will be few asset retirements. The method gives a high weight to recently purchased assets, however, since they are the least depreciated while considered equally likely to enter the capital stock now as decades ago. This boosts the correction factors in 1989 and 1990 (up to factors of 6, depending on the hypothesized lifetime and price index). The graph on the right in figure 3 therefore ignores these outlier years.

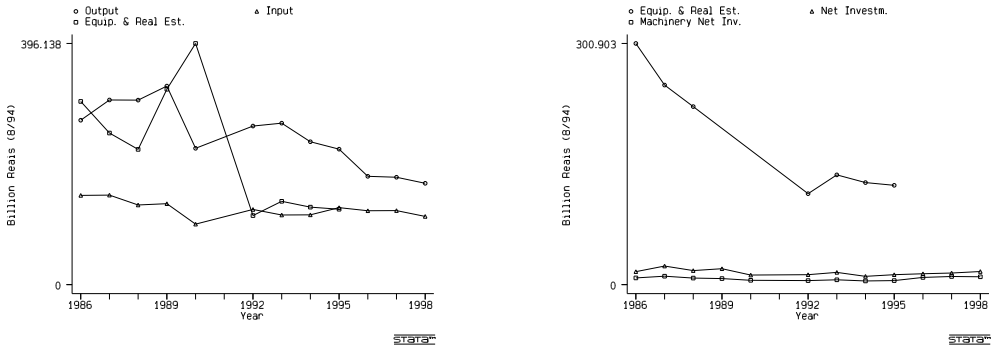
Second, the capital stock is continuously falling through 1986 until 1990, while net investment both in sum and for machinery hardly responds (the method has a levelling effect on net investment through its adjustment of asset retirements). The implied annual depreciation rate between 1986 and 1990 is very high (25 per cent in 1987 and 18 per cent in 1988), while it attains reasonable levels (of about 14 and 12 per cent) after 1992.[14] This may seem unreasonable; it would be ruled out by a criterion on implicit depreciation such as: 'Reject a series if implicit depreciation reaches 20 per cent or more in any year'. Note that the capital stock in this definition includes buildings, which depreciate little even under high capacity utilization.

5.7 A method satisfying consistency criteria

While seemingly compelling from a theoretical point of view, the correction method is not likely to pass reasonable criteria on implicit depreciation. The method has the advantage, however, to provide a theoretically well-grounded correction factor for the effects of the optional revaluation in 1991. In a word, it seems reasonable to keep the uncorrected values for the capital stock before 1990. In addition, the capital stock figures after 1991 are readjusted by an appropriate factor to make them comparable to 1990 values. There are several arguments in favor of this procedure.

First, the worsening picture after applying the correction factors lends support

[14]Since the capital stock K_t evolves according to the relationship $K_{t+1} = J_{t+1} + (1 - \delta_t)K_t$ under net investment I_{t+1} and depreciation $\delta_t K_t$, the implicit depreciation rate is inferred as $\delta_t = [I_{t+1} - (K_{t+1} - K_t)]/K_t$ in every year.



Data: Unbalanced panel of all firms in *PIA* 1986-1998. Figures are unweighted sums.

Figure 3: Value added, net investment, and a preliminary capital series

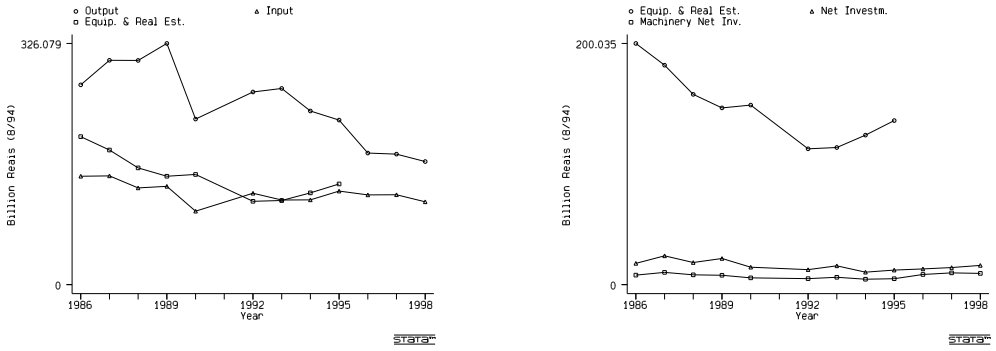
to the hypothesis that the values in *PIA* are not that far off the mark after all. Second, when the correction factor method does a good job—before 1988 and after 1992—, the rates of change in the capital stock exhibit the same tendencies as the raw series. Between 1986 and 1988, the partially corrected capital stock falls by 26 per cent, while it falls by 37 per cent in the raw series. From 1992 until 1995, the capital stock in the partially corrected series increases by 9 percent, while the raw capital stock goes up by 21 per cent. So, apart from raising the levels in every year, the partial correction method has a smoothing effect on the series. Except for the hyper-inflation years 1989 and 1990, it resembles the movements in the raw series. The partial correction method confirms the pattern of changes in the raw series, albeit diverging to a certain degree in the absolute figures.

Third, it is highly likely that firms apply a monetary correction to their assets that preserves possibly much of the real asset value. While the governmentally administered price index forces them to undervalue their assets, firms have strong incentives to exploit ways to keep their book values as close to real values as possible. Income taxation makes this a strictly preferable strategy. Since losses from monetary correction cannot be claimed in full—the governmentally administered price index supposes that there is no such monetary loss—, firms would forego the profit reducing effect of the correct depreciation of their assets and pay unduly high taxes. Consequently, firms have strong incentives to keep assets from losing book value, to keep depreciation costs possibly high and close to the real depreciation costs, and to reduce their reported profits, that is taxable income, by these depreciation costs in subsequent years in order to save taxes. The only way to achieve this is to pencil in book values of the assets as close to real values as possible. So, the main problem of the series does not seem to be the continuous undervaluation of assets, which to

avoid firms had strong incentives. The main problem rather seems to be the optional revaluation in 1991 because firms had incentives to report as high a revaluation as they could.

Fourth, the partial correction method provides a theoretically sound basis for the correction of the revaluation in 1991, the major problem in the raw series. What, then, is the right factor to adjust capital stock figures in 1992 and thereafter to figures before? Annual correction factors are calculated under assumption (i) (in the preceding section), which states that almost all firms re-value and that those that don't have negligibly little to change. The ratio between the correction factor for 1992 and the correction factor of each preceding year shows how far the capital stock in the preceding year should be elevated to make the series conform. In other words, the ratio between the correction factor for 1992 and the correction factor of each preceding year measures the degree of revaluation that firms could reasonably claim to be justified in front of the tax authorities. The year 1992 appears to be the year in *PIA* that contains arguably the least error—above all, it immediately follows the revaluation year 1991. Since the correction factors for 1989 and 1990 have proven to be out of reasonable range (due to the underrepresented hyper-inflation in the official price index and firms' strong incentives to avoid applying the official index in full), the correction factors for 1986 through 1988 seem the most appropriate base for comparison to 1992. Dividing the 1992 factor by the mean of the factors between 1986 and 1988 yields a ratio of about 2.04 in the case of *IPA-DI* and of about 2.19 in the case of *IGP-DI*, for instance. This indicates the average difference between a wrongly priced capital good's value in 1986 and its equivalent in 1992. Simply multiplying the capital stock figures between 1986 and 1988 by this ratio would boost high values even higher. I therefore chose to multiply the average capital stock in 1986 and 1990 by the factor, to then subtract the average of the raw figures between 1986 and 1990, and to add the so obtained absolute difference in levels to all raw capital stock figures between 1986 and 1990, for every firm. This procedure shifts the left arm of the series to the North, rather than turning it around the midpoint in 1988. This accounts for the fact that the capital stocks in 1989 and 1990 should get a stronger push than the earlier ones since inflation is particularly high in 1989 and 90. Figure 4 shows the resulting series in the aggregate.

This procedure yields a declining capital stock over the period from 1986 until 1992. The relative decline that occurs between 1986 and 1988 continues from 1990 to 1992. Substantial political and economic uncertainty marks the period. The relatively levelled net investment flow series implies a substantially higher depreciation rate between 1986 and 1990 (18 per cent on average) than between 1992 and 1995 (4 per cent on average). Improved quality of the capital goods and lower utilization of installed capacity may contribute to this. They are unlikely to explain all the difference so that valuation problems in the capital stock series may in fact remain. The evolution of the series is roughly supported by the reported annual depreciation cost in *PIA* (`deprec`)—a variable measured as well or as badly as annual asset



Data: Unbalanced panel of all firms in *PIA* 1986-1998. Figures are unweighted sums.

Figure 4: Value added, net investment, and the corrected capital series

retirements. If one proxies the annual depreciation rate with the ratio between this variable (`deprec`) and the initial capital stock (`aspimmo` at the beginning of the year), the average depreciation rate over all sectors and regions would be 7 per cent between 1986 and 1990, and 5 per cent between 1992 and 1995. Clearly, this decline is less pronounced than the series in figure 4 suggests. Its direction, however, seems to confirm the overall picture.

Depending on the exact criteria one wants to impose for mutually consistent investment and capital stock figures, the resulting series will differ. It seems likely, however, that they roughly resemble the picture of the series in figure 4. The capital stock series ends in 1995. The completion of the capital stock series until 1998 in the following subsection will show that a continued capital accumulation throughout the 1990s compensates for the reduction of the capital stock during the late 1980s.

5.8 Connecting capital stock series between *PIA velha* and *PIA nova*

PIA nova only offers investment flow variables, and no information on levels. So, to extend the capital stock series beyond 1995, a variant of the perpetual inventory method needs to be applied in one form or another. Following the insights from subsection 5.7 I use the deflated values of the raw series after 1995 (and adjust the figures before 1991).[15]

Net investment flows result as the difference between gross investment and asset

[15]This is further supported by the fact that the earlier understating of inflation now sometimes turns into an overstating. The freezing of *UFIR* over longer periods of time makes the correction factor drop below unity for short-lived goods after 1996.

retirements. To derive capital stock figures for 1996 and beyond, an assumption about the likely depreciation rate needs to be made. Consistency suggests to use either values from table 14, or to apply an average of implicit depreciation between 1986 and 1995. I use an imputation procedure, described in detail in subsection 5.9. Taken together, these steps allow to construct consistent series of the capital stock and related variables for the firms in *PIA* between 1986 and 1998.

Finally, many firms rent or lease both buildings and equipment. To complete the estimate of a capital stock series, the capitalized value of these rental and leasing rates has to be added in. *PIA* provides two variables, `asrtimmo` and `aslsimmo`, that contain information on rented assets. However, these variables do not allow to distinguish between types of capital goods. So, it will be necessary to make assumptions on their separation if one wants to incorporate rented assets at lower than the aggregate level of the capital stock (*ativo imobilizado*). I typically include them in the structures variable for production function and productivity estimation (Muendler 2003b, Muendler 2003c).

5.9 Total capital: Equipment and structures

The closest variable to the total capital stock in *PIA* is *ativo imobilizado* (`aspimmo`). It embraces everything from real estate and buildings, to equipment, vehicles, and computers. However, no information on capital utilization rates is available. I infer a series for the capital stocks from the data using a perpetual inventory method. I choose this method mostly because it relates best to the afore-mentioned accounting and correction principles that determine the observed balance sheet figures.

Over the course of the years, *PIA* questionnaires are reduced and only investment flows become available in later years while several variables on stocks of capital goods were available before. In addition, rental and leasing cost are only reported as totals so that the rental of subgroups of capital goods cannot be inferred directly. Therefore, I typically split the capital stock into three parts (Muendler 2003b, Muendler 2003c): Domestic equipment, foreign equipment, and the remaining parts of the total capital stock (corresponding to *ativo imobilizado* in the balance sheet, plus the present discounted value of the rental stream, less equipment stock). The underlying hypothesis is that rental and leasing is mostly used for buildings and vehicles, and less for equipment.

The following three-step procedure yields a coherent capital stock series for each individual firm. While the underlying depreciation rates are imputed (through linear regression and prediction), the capital stock figures are inferred from the according accounting identity $\overline{K}_{t,i}^{tot} = (1-\hat{\delta}_{t,i}^{tot})\underline{K}_{t,i}^{tot} + I_{t,i}^{tot}$ for every firm i—a perpetual inventory method. The notation here reflects the timing of the observed balance sheet figures. The beginning-of-year capital stock $\underline{K}_{t,i}^{tot}$ in year t equals the end-of-year capital stock $\overline{K}_{t-1}^{tot}$ of the preceding year.

Step 1: Since no survey is conducted in 1991, the initial *total* capital stock for

1992 is missing. Given an estimate of the depreciation rate, $\hat{\delta}^{tot}_{92,i}$, the initial capital stock in 1992 results as $\underline{K}_{92,i} = (\overline{K}_{92,i} - I_{92,i})/(1 - \hat{\delta}^{tot}_{92,i})$. The firm-specific depreciation rate for 1992 is imputed in two stages: First, a firm-specific depreciation rate $\hat{\delta}^{tot}_{t,i}$ is calculated for every firm and year (86-90, and 93-95) as the ratio between the reported total depreciation cost and the initial total capital stock: $\hat{\delta}^{tot}_{t,i} = D^{tot}_{t,i}/\underline{K}_{t,i}$. Total depreciation cost $D^{tot}_{t,i}$ is an observed variable in *PIA*. Second, regressing this firm and year-specific depreciation rate on a constant and on total depreciation cost allows one to predict the missing firm-specific depreciation rate for 1992. If depreciation cost is missing in 1992 or the regression has too few observations, the predicted sector and region wide depreciation rate $\sum_{i\in(\mathbb{S}\cap\mathbb{R})}^{N} \hat{\delta}^{tot}_{t,i}/N$ is used instead.

Step 2: *PIA* contains no total capital stock figures after 1995. The end-of-year capital stock figures from 1996 until 1998 are inferred as $\overline{K}^{tot}_{t,i} = (1 - \tilde{\delta}^{tot}_{i})\underline{K}^{tot}_{t,i} + I^{tot}_{t,i}$, where $\tilde{\delta}^{tot}_{i}$ is calculated as the firm-specific average between 1992 and 1995: $\tilde{\delta}^{tot}_{i} = \sum_{s=92}^{95} \hat{\delta}^{tot}_{s,i}/4$. Since a structural break may occur between 1990 and 1992, depreciation rates in earlier years are not included at this stage.

Step 3: Firms rent and lease more assets after 1992. In addition, smaller firms rent a larger share of their capital stock. In order to prevent a bias from the higher renting and leasing activity after 1992 and among smaller firms, capital stock equivalents to the rental rates are constructed and added to the proprietary capital stock. Brazil does not dispose of data on rental rates for a firm's typical capital stock.

So, the following procedure is adopted to infer rental rates. Rental and leasing rates must compensate for the user cost of capital, that is for both foregone real interest and depreciation. In equilibrium, the annual rental rate in year t, d_t, must equal the annualized monthly real interest rate in year t plus the typical annual depreciation rate at firm i: $d_t = r_t + \hat{\delta}_{i,t}$. The real interest rate is calculated as the monthly interest rate on a savings account (*poupança*). Researchers regard the monthly savings account interest rate as a good indicator of opportunity cost for investments in Brazil, especially since risk-adjusted yields of assets fluctuate considerably. A consistent savings account interest rate series (*Caderneta de Poupança - Rendimento Mensal*) is available from *Associação Nacional das Instituições do Mercado Aberto* through *Fundação Getúlio Vargas*, Rio de Janeiro (*FGV Dados*). The monthly nominal interest rate is purged of monthly inflation using the national consumer price index *INPC*, and then annualized. The years 1989 and 1990 are disregarded as they are characterized by unexpectedly high inflation, resulting in negative real interest rates of as low as -25%. The rental rates for buildings and equipment cannot have been based on such expectations so that these interest rates are discarded. Instead, for the years 1986 through 1990, the average real interest rate between 1986 and 1988 is used (5.3 percent). Similarly, for the periods 1992 until 1995, and 1996 until 1998, the according four and three-year averages are used (10.3 and 10.0 percent, respectively). The annual depreciation rates are calculated for every firm using the method in step 1. They are then averaged, for each firm, in

the same three subperiods to remove fluctuations which are unlikely to have been the basis for rental rates. The rented capital stock then results as $\overline{K}_t^{rent} = D_{i,t}/(\bar{r}_t + \hat{\bar{\delta}}_{i,t})$, where $D_{i,t}$ denotes firm i's rental and leasing expenditure in year t, and $\bar{r}_t$ and $\hat{\bar{\delta}}_{i,t}$ the according period-averages of the real interest rate and the depreciation rate.

Wherever possible, missing values in *PIA*'s capital stock figures are imputed as $\overline{K}_{t,i} = (1 - \hat{\delta}_{t,i})\underline{K}_{t,i} + I_{t,i}$, using an estimate of the depreciation rate as in step 1. *PIA* does not distinguish between missing and zero-value observations prior to 1996. For these early years, missing or zero-value stock observations are assumed to be missing values in fact, whereas missing or zero-value figures for investment flows are considered to be zero if and only if investment flows in similar or related variables are observed. For example, if equipment acquisitions are not observed while equipment retirements are, the missing or zero-value entry is treated as zero. It is left missing if, for instance, total investment flows are observed but no flows related to equipment. Alternatively, I try direct imputation (regression and prediction) methods for capital stock values. The resulting series were highly volatile and produced a considerable share of unreasonable outliers. Therefore, the mixture of imputed depreciation and inferred stock values seems preferable.

5.10 Domestic and foreign equipment

The following five-step procedure yields a coherent equipment stock series.

Step 1: Since no survey is conducted in 1991, the initial *total* capital stock for 1992 is missing. The results from step 1 above are reused (appendix 5.9).

Step 2: Beginning and end-of-year *equipment* stock figures are available between 1986 and 1990, but not thereafter, and the year 1991 is missing. The initial equipment stock in 1992 is inserted using the average share of equipment in total capital in the beginning of all preceding years 1986 through 1991 (the beginning-of-year value is recorded for 1986, and the 1991 value is inferred from the 1990 end-of-year value): $\hat{\phi}_{92,i} = \sum_{s=86}^{91}(\underline{K}_{s,i}^{mach}/\underline{K}_{s,i}^{tot})/6$. Then, $\underline{K}_{92,i}^{mach} = \hat{\phi}_{92,i}\underline{K}_{92,i}^{tot}$. If the firm is the legal or economic successor of another firm and emerges either in 1991 or 1992, the according ratio of the predecessor firm is used. If a firm is new born or a firm-specific estimate for $\hat{\phi}_{92,i}$ is missing for some other reason, the average of the sector and region is used ($\sum_{s\in\{86,\ldots,90\},i\in(\mathbb{S}\cap\mathbb{R})}^{N}(\underline{K}_{s,i}^{mach}/\underline{K}_{s,i}^{tot})/6N$). If a firm is created in a year after 1992 by some parent firm, its parent's capital structure is copied. If a greenfield creation emerges after 1992, the typical capital composition in the firm's sector and region is imposed as starting structure.

Step 3: The end-of-year equipment stock between 1992 and 1998 is no longer reported in *PIA*. These values are inferred from the accounting relation $\overline{K}_{t,i}^{mach} = (1 - \hat{\delta}_{t,i}^{mach})\underline{K}_{t,i}^{mach} + I_{t,i}^{mach}$, starting in 1992 and moving forward to 1998. When an investment flow is missing in an intermediate year, the average of the equipment flow in two neighboring years is used, weighted by the according total flow figure, in

order to preserve subsequent observations. An estimate of the firm and year-specific equipment depreciation rate $\hat{\delta}_{t,i}^{mach}$ is derived applying the following procedure: First, total depreciation rates for every firm and year are computed as in step 1 in the previous subsection 5.9, using the total depreciation cost reported in *PIA*. Second, since no explicit equipment depreciation cost figure is available in *PIA*, an estimate of the average lifetime ratio between equipment and the total capital stock is obtained. In steady state (and the years 1986 through 1989 are assumed to come close to a steady state), the ratio between the average lifetime of equipment and total capital stock must be equal to the inverse of the ratio between the depreciation rates for equipment and total capital stock. Also, the ratio of average lifetimes can be approximated by average turnover:

$$\frac{\hat{\delta}_{t,i}^{mach}}{\hat{\delta}_{t,i}^{tot}} = \frac{\text{Avg. Lifetime Total Capital}_{(t,i)}}{\text{Avg. Lifetime Equipment}_{(t,i)}} \approx \frac{\frac{I_{t,i}^{mach}}{(\underline{K}_{t,i}^{mach}+\overline{K}_{t,i}^{mach})/2}}{\frac{I_{t,i}^{tot}}{(\underline{K}_{t,i}^{tot}+\overline{K}_{t,i}^{tot})/2}}, \tag{11}$$

where average turnover is defined as the annual gross flow divided by the annual average stock. Note that in steady state annual gross investment just replaces depreciated capital $I_t = \delta_t \underline{K}_t$. (Alternatively, the implicit equipment deprecation in the years 1986 through 1990 is calculated as: $\hat{\delta}_t^{mach}(1+(I_t-\bar{K}_s)/\underline{K}_s)$ but figures are found to be too erratic to base further derivations on them.) In *PIA*, the lifetime ratio (11) fluctuates strongly across regions and sectors but is fairly stable over the years. On average, it amounts to 1.37. That is, the lifetime of equipment is about 37 percent shorter than that of an average capital good in steady state. Since buildings and real estate enter the total capital stock but depreciate little, this figure seems reasonable. In addition, Brazilian accounting rules of thumb take ten years as the average lifetime of equipment, 25 years for buildings and between four and six years for cars, computers, and the like; this yields an average of roughly 14 years of life for the average total capital stock of a typical Brazilian firm—the ratio of 14 by 10 is close to the figure estimated here. Since it seems more plausible to assume that the manufacturing sector as a whole found itself in steady state than to assume that every single sector is in steady state, this overall ratio of 1.37 is applied to all sectors. The firm and year-specific equipment depreciation rates are set to $\hat{\delta}_{t,i}^{mach} = 1.37 \cdot \hat{\delta}_{t,i}^{tot}$, where $\hat{\delta}_{t,i}^{tot}$ is the same as in step 1. It is likely that most of the fluctuations in the depreciation cost for a firm come from equipment and short-lived capital goods, rather than from ground and premises. So, observed fluctuations in the overall depreciation rate should be carried through to equipment depreciation. The present method does that.

Step 4: As regards foreign equipment, only acquisitions are observed in *PIA*. They need to be used to infer stock values over the sampling period. Since the manufacturing sector is closest to a steady state in the mid eighties, the following method tries to infer a likely foreign equipment stock in the earliest possible

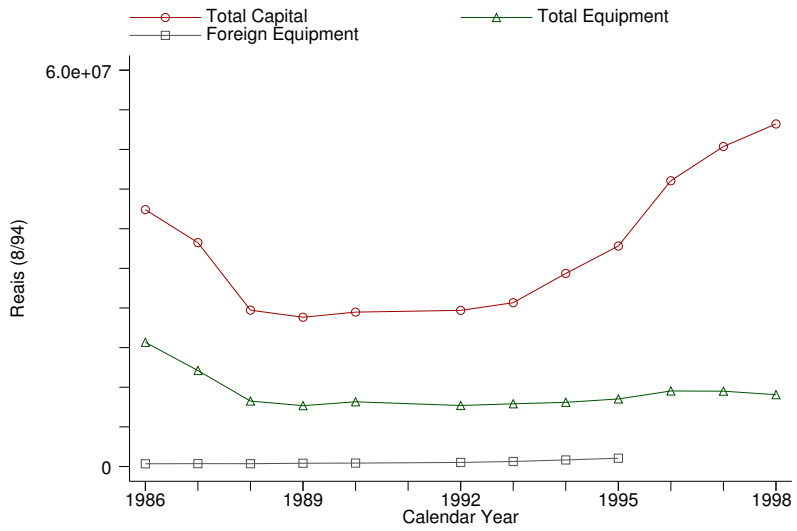
year and to depart from this estimate subsequently. Firms in *PIA* are conveniently split into two groups: (a) Firms born in 1985 or before, and (b) firms born in 1986 or during the sampling period. Turn to group (a) first. Under the hypothesis that Brazilian manufacturing is close to a steady state in the mid eighties, the beginning-of-year foreign equipment stock in 1986 is set equal to $\underline{K}^{mach,*}_{86,i} = \sum_{s=86}^{88}(Acq^{mach,*}_{s,i}/Acq^{mach}_{s,i})/3 \cdot \underline{K}^{mach}_{86,i}$, where $Acq^{mach,*}_{t,i}$ and $\underline{K}^{mach,*}_{t,i}$ denote foreign equipment acquisitions and stocks, respectively. If a firm is recorded born before 1986 but appears in *PIA* only after 1986, the average share of foreign equipment acquisitions in the first two years of observations is used (instead of the three-year mean, as above). Turn to group (b) which contains new firms that enter *PIA* in or after 1986. If these firms are greenfield creations, their initial foreign equipment stock in 1986 is set to zero. If these firms have a legal or economic predecessor in *PIA*, the share of foreign equipment in the predecessor's total equipment stock in the year of succession is transferred to the successor as the adequate share of foreign equipment. If the firm is no greenfield creation but the predecessor is not observed in *PIA* in any previous year, the method of group (a) is applied.

Step 5: The foreign equipment stock in all subsequent years, following the first year of observation of a firm, are inferred from the relationship $\overline{K}^{mach,*}_{t,i} = Acq^{mach,*}_{t,i} + \underline{K}^{mach,*}_{t,i}(1 - \hat{\sigma}^{mach}_{t,i} - \hat{\delta}^{mach}_{t,i})$. Under the assumption that a firm is equally likely to retire a domestic machine as it is to retire a foreign machine, the retirement of foreign equipment is approximated by $\hat{\sigma}^{mach}_{t,i}\underline{K}^{mach,*}_{t,i}$, where $\hat{\sigma}^{mach}_{t,i}$ is computed as $\hat{\sigma}^{mach}_{t,i} = Ret^{mach}_{t,i}/\underline{K}^{mach}_{t,i}$ ($Ret^{mach}_{t,i}$ denotes equipment retirements). Similarly, the assumption that foreign equipment depreciates at the same rate as domestic equipment is made and $\hat{\delta}^{mach}_{t,i}$ is calculated as in step 3. Finally, the problem to bridge the missing year 1991 occurs again. Applying similar arguments as in step 2, one can calculate $\hat{\phi}^{*}_{92,i} = \sum_{s=86}^{91}(\underline{K}^{mach,*}_{s,i}/\underline{K}^{mach}_{s,i})/6$ or an accordingly adjusted factor if years are missing (see step 2). Then, $\underline{K}^{mach,*}_{92,i} = \hat{\phi}^{*}_{92,i}\underline{K}^{mach}_{92,i}$. The remaining end-of-year stocks from 1992 until 1995 is inferred applying $\overline{K}^{mach,*}_{t,i} = Acq^{mach,*}_{t,i} + \underline{K}^{mach,*}_{t,i}(1 - \hat{\sigma}^{mach}_{t,i} - \hat{\delta}^{mach}_{t,i})$ again.

Wherever possible, missing values in *PIA*'s capital stock figures are imputed as $\overline{K}_{t,i} = (1 - \hat{\delta}_{t,i})\underline{K}_{t,i} + I_{t,i}$, using an estimate of the depreciation rate as in step 1 for total capital stock figures, and as in step 3 for the equipment stock. Throughout the construction of series for types of equipment, all components of the equipment stock are restricted to sum to the total.

5.11 Domestic equipment and its components

The domestic equipment stock can be split into further components until 1995. Vehicles, computers, and other capital goods are separately reported in *PIA velha*. According series are obtained with a procedure analogous to *Step 4* and *Step 5* in the preceding subsection. Contrary to the procedure for total assets and machinery,



Data: Unbalanced panel of all firms in *PIA* 1986-1998. Figures are unweighted sums.

Figure 5: Firm-average capital stock, equipment and foreign equipment

I do not apply the correction factor from section 5.7 to vehicles, computers, and other capital goods. Similar to buildings, vehicles and computers behave differently than total assets and machinery before 1990 (1986-90). In the case of the computer stock, for instance, the computed correction factor from section 5.7 would be 5.04. However, I use 3.5—the implied factor from accounting principles (table 15)—since otherwise $\delta > 1$ for computers.

Figure 5 shows the firm-average capital stock, equipment stock and foreign equipment stock as they result from the above efforts. Especially after the *Plano Real* stabilizes the economy in 1995, investment in the capital stock takes off. Foreign equipment is steadily accumulated from the late 1980s on.

5.12 Remarks on deflating liabilities

The correct valuation of liabilities in *PIA* remains an open issue. As discussed for the capital stock series, I play investment flows and depreciation rates against the stock series until I reach a mutually consistent series under a given set of reasonable criteria. There is no such choice for liability valuation since flows are not reported in *PIA* (and not recorded in a balance sheet in general). In addition, asset revaluations affect equity and thus the value of total liabilities. I therefore assess liability variables mainly through internal ratios such as the debt share in total liabilities, or the share of foreign short-term debt in total short-term liabilities and the like. Ratios such as liabilities per output would already pose a valuation problem that remains to be

resolved. Some of these ratios can, surprisingly, exceed unity. The ratio of credit per total liabilities, for instance, can become larger than one since Brazilian accounting principles allow firms to show negative equity in their balance sheet temporarily.[16]

[16] Arguably, end-of-year values of economy-wide or industry-wide price indices could be applied to deflate the sum of credit, `crtot`. Since revaluations of assets, such as the optional revaluation programme in 1991, only affect the value of equity, the value of the sum of all credits would not be altered by this. Candidate economy-wide price indices to deflate the sum of credit (`crtot`) are *INPC* or *IGP-DI*. Just as in the case of flow variables, however, the use of a less general deflator may be more appropriate in the context of a firm's decision making process. For the firm, its decision to raise capital may depend on the relative prices of factors, and the relative sales price for final products. Therefore, another adequate deflator choice may be the use of industry-specific rather than economy-wide price indices. In particular, the use of the *IPA-OG* and *IPA-DI* series for deflating outputs and intermediate goods inputs, suggest the use of the industry-wide prices indices within the *IPA-OG* or *IGP-DI* series, too, to deflate the sum of credit, `crtot`.

Appendix

A Sectors of Industry

Firms in *PIA velha* are classified into sectors at the so-called *nível 100* (level 100). The definition of sectors of industry according to *nível 100* corresponds roughly to the three-digit *SIC* level in the US. *Nível 100* comes close to the sectoral definitions in the Brazilian national accounting system. However, the actual accounting system uses a classification system called *nível 80* which aggregates several manufacturing sectors in a slightly different way. Both *nível 100* and *nível 80* use a number system with four digits. The first two digits are identical in both systems (usually called *atividade 80*, *atividade 100*, or *nível 50*) and provide the simplest manner to move from *nível 100* to *nível 80*, and vice versa. However, it is possible to derive a finer mapping between sector definitions at *nível 80* and *nível 100*. Sectors 801 and 802, for instance, can be separated and correspond one-to-one to 810 and 820, respectively.

A.1 Compatibility between *Nível 100* and *CNAE*

Firms in *PIA nova* are classified according to a new system called *CNAE* (*Classificação Nacional de Atividades Empresariais*) which comes closer to international classifications. The following list shows how *CNAE* is transformed back to *nível 100* according to an internal recommendation at *IBGE*.

Nív.100	*CNAE*
210	1310, 1321, 1322, 1323, 1324, 1325, 1329
220	1410, 1421, 1429
310	1110, 1120
320	1000
410	2620
420	2630
430	2611, 2612, 2619
440	2641, 2642, 2649, 2691, 2692, 2699
510	2711, 2712, 2721, 2722, 2729
610	2741, 2742, 2749, 2752, 2832
710	2751, 2831
720	2731, 2739, 2811, 2812, 2833, 2834, 2839, 2841, 2842, 2843, 2891

Nív.100	*CNAE*
	2892, 2893, 2899
810	2813, 2821, 2822, 2911, 2912, 2913, 2914, 2915, 2921, 2922, 2923
	2924, 2925, 2929, 2931, 2940, 2951, 2952, 2961, 2962, 2963, 2964
	2965, 2969, 2971, 2972
820	2932, 2953, 2954
1010	3111, 3112, 3113, 3121, 3122
1020	3130, 3141, 3151, 3152, 3191
1030	2981, 2989, 3011, 3199
1110	3012, 3021, 3022, 3192, 3210, 3221, 3222, 3330
1120	3230
1210	3410, 3420, 3431, 3432, 3439
1310	3142, 3160, 3441, 3442, 3443, 3444, 3449, 3450
1320	3511, 3512
1330	3521, 3522, 3523
1340	3531, 3532, 3591, 3592, 3599
1410	2010, 2021, 2022, 2023, 2029
1420	3611, 3612, 3613, 3614
1510	2110
1520	2121, 2122, 2131, 2132, 2141, 2142, 2149
1530	2211, 2212, 2213, 2214, 2219, 2221, 2222, 2229, 2231, 2232
	2233, 2234
1610	2511, 2512, 2519
1710	2411, 2414, 2419, 2429
1720	2340
1810	2320
1820	2421, 2422
1830	2431, 2432, 2433, 2441, 2442
1910	2412, 2413
1920	2461, 2462, 2463, 2469, 2472, 2481, 2482, 2483, 2491, 2492, 2493
	2494, 2496, 2499, 2310, 2330
2010	2451, 2452, 2453, 2454
2020	2471, 2473
2110	2521
2120	2522, 2529
2210	1711, 1719, 1721, 1722, 1731, 1732
2220	1723, 1733
2230	1724, 1741, 1749, 1750, 1761, 1762, 1763, 1764, 1769, 1771
	1772, 1779
2310	1811, 1812, 1813, 1821, 1822
2410	1910, 1921, 1929
2420	1931, 1932, 1933, 1939

Nív.100	*CNAE*
2510	1571, 1572
2610	1551
2620	1552
2630	1521, 1522, 1523, 1585
2640	1553, 1554, 1555, 1559, 1583
2650	1600
2710	1511, 1513
2720	1512
2810	1541, 1542
2910	1561, 1562
3010	1531
3020	1532, 1533
3110	1556
3120	1422, 1514, 1543, 1581, 1582, 1584, 1586, 1589
3130	1591, 1592, 1593, 1594, 1595
3210	2495, 3310, 3320, 3340, 3350, 3691, 3692, 3693, 3694, 3695, 3696 3697, 3699, 3710, 3720

A.2 Compatibility between *Nível 100*, *IPA-DI* and *IPA-OG*

The list below shows how the sectoral definition of *nível 100* are made compatible with the respective classifications in the price index series *IPA-DI* and *IPA-OG*. The list is joint work with Adriana Schor at Fundação Getúlio Vargas, São Paulo.A list of the *IPA-DI* indices is given in subsection A.3 below.

Nív.100	*50*	Portuguese Description of Sector	*IPA-DI*	*IPA-OG*
210	2	Extração de minerais metálicos	mpr	28
220	2	Extração de minerais nao-metálicos	mpr	28
310	3	Extração de petróleo e gas natural	mpr	28
320	3	Extração de carvão mineral	mpr	28
410	4	Cimento e clínquer	constr	30
420	4	Peças e estruturas de concreto	constr	30
430	4	Vidro e artigos de vidro	mpr	30
440	4	Outros minerais não-metálicos	mpr	30
510	5	Siderurgia	mpr	32
610	6	Metalurgia dos não-ferrosos	mpr	33
710	7	Fundidos e forjados de aço	mpr	32
720	7	Outros produtos metalúrgicos	mpr	31
810	8	Máquinas, equipamentos e instalações	maq	36
820	8	Tratores e máquinas rodoviárias	maq	35

Nív.100	*50*	Portuguese Description of Sector	*IPA-DI*	*IPA-OG*
1010	10	Equipamentos para energia elétrica	maq	40
1020	10	Condutores e outros materiais elétricos	mpr	41
1030	10	Aparelhos e equipamentos elétricos	bcd-ud	39
1110	11	Material para aparelhos eletrônicos	mpr	38
1120	11	TV, radio, e equipamentos de som	bcd-ud	41
1210	12	Automóveis utilitários	veiculos	43
1310	13	Motores e peças para veículos	compveic	41
1320	13	Indústria naval	trans	44
1330	13	Indústria ferroviária	trans	44
1340	13	Fabricação de outros veículos	trans	43
1410	14	Indústria da madeira	mpr	45
1420	14	Indústria do mobiliário	bcd-ud	46
1510	15	Celulose e pasta mecânica	mpr	50
1520	15	Papel, papelão e artefatos de papel	mpr	50
1610	16	Indústria da borracha	mpr	51
1710	17	Elementos químicos não petroquímicos	mpr	58
1720	17	Destilação de álcool	mpr	54
1810	18	Refino de petróleo	mpr	54
1820	18	Petroquímica	mpr	58
1830	18	Resinas, fibras e elastomeros	mpr	56
1910	19	Adubos e fertilizantes	mpr	57
1920	19	Produtos químicos diversos	mpr	53
2010	20	Indústria farmac eutica	bcnd	81^a
2020	20	Indústria de perfumaria, sabões e velas	bcnd	82^a
2110	21	Laminados plásticos	mpr	83^a
2120	21	Artigos de material plástico	bcnd	83
2210	22	Beneficiamento de fibras naturais	mpr	60
2220	22	Fiação de fibras artificiais	mpr	61
2230	22	Outras indústrias téxteis	mpr	65^a
2310	23	Artigos do vestuario e acessórios	bcnd	63
2410	24	Indústria de couros e peles	mpr	52
2420	24	Calçados	bcnd	64
2510	25	Indústria do café	bcnd-alim	75^a
2610	26	Beneficiamento do arroz	bcnd-alim	76^a
2620	26	Moagem de trigo	mpr	72
2630	26	Conservação de frutas e legumes	bcnd-alim	76
2640	26	Outros produtos vegetais	bcnd-alim	76
2650	26	Indústria do fumo	bcnd	69
2710	27	Preparação de carnes	bcnd-alim	78
2720	27	Preparação de aves	bcnd-alim	78
2810	28	Preparação do leite e laticínios	bcnd-alim	79

Nív.100	*50*	Portuguese Description of Sector	*IPA-DI*	*IPA-OG*
2910	29	Indústria do açucar	bcnd-alim	73
3010	30	Óleos vegetais em bruto	mpr	74
3020	30	Refino de óleos vegetais	bcnd-alim	74
3110	31	Alimentos para animais	mpr	80
3120	31	Outras indústrias alimentícias	bcnd-alim	80
3130	31	Indústria de bebidas	bcnd-alim	66
3210	32	Outras indústrias	ipadi	29

[a]The price index series *IPA-OG* 65, 75, 81, 82, and 83 begin in March 1986, and *IPA-OG* 76 in January 1970. Their earlier years are replaced with according aggregate indices, rebased to the connecting year: 65 with 59, 75 and 76 with 71, and 81 through 83 with 29.

A.3 Categories of *IPA-DI* price index series

The abbreviations for *IPA-DI* price indices are explained in the table below. As the table shows, several aggregate categories of indices are not used.

Category	*IPA-DI* series (Portuguese description)
ipadi	Total - Média Geral
.	Bens de Consumo - Total
bcd	Bens de Consumo Duráveis - Total
.	Bens de Consumo Duráveis - Outros
bcd-ud	Bens de Consumo Duráveis - Utilidades Domésticas
bcnd	Bens de Consumo Não Duráveis - Total
bcnd-alim	Bens de Consumo Não Duráveis - Gêneros Alimentícios
.	Bens de Consumo Não Duráveis - Outros
.	Bens de Produção - Total
compveic	Bens de Produção - Componentes para Veículos[a]
.	Bens de Produção - Máquinas, Veículos e Equipamentos, Total
maq	Bens de Produção - Máquinas e Equipamentos
veic	Bens de Produção - Veículos Pesados para Transporte
constr	Bens de Produção - Materiais de Construção
mpr	Bens de Produção - Matérias Primas, Total
.	Bens de Produção - Matérias Primas Brutas
.	Bens de Produção - Matérias Primas Semi-Elaboradas
.	Bens de Produção - Outros
veiculos	Unweighted mean of *bcd* and *veic*
	Bens de Consumo Duráveis - Total
	Bens de Produção - Veículos Pesados para Transporte
trans	Unweighted mean of *compveic* and *veic*
	Bens de Produção - Componentes para Veículos[a]
	Bens de Produção - Veículos Pesados para Transporte

[a]Only since 1986.

A.4 English descriptions of sectors at *Nível 100*

A list of English descriptions of sectors at *nível 100* is given below.

Nível 100	English description
2	**Mineral Mining (except combustibles)**
210	Metal Ore Mining
220	Nonmetallic Minerals Mining
3	**Petroleum and Gas Extraction and Coal Mining**
310	Petroleum and Gas Extraction
320	Coal Mining
4	**Nonmetallic Mineral Goods Manufacturing**
410	Cement Manufacturing
420	Cement, Concrete and Gypsum Product Manufacturing
430	Glass and Glass Product Manufacturing
440	Nonmetallic Mineral Product Manufacturing
5	**Iron and Steel Production and Processing**
510	Iron and Steel Production and Processing
6	**Nonferrous Metals Production and Processing**
610	Nonferrous Metals Production and Processing
7	**Other Metal Products Manufacturing**
710	Iron and Steel Foundries and Forgings
720	Other Metal Products Manufacturing
8	**Machinery, Equipment and Commercial Installation Manufacturing (including parts and accessories)**
810	Machinery, Equipment and Commercial Installation Manufacturing (including parts and accessories)
820	Road Construction Machinery and Tractor Manufacturing
9	**Machinery Maintenance, Repairing and Installation**
910	Machinery Maintenance, Repairing and Installation
10	**Electrical Equipment and Components Manufacturing**
1010	Electrical Products Manufacturing for Power Generation and Distribution

Nível 100	English description
1020	Electric Conductor and Other Electrical Device Manufacturing (except for vehicles)
1030	Electric Appliance and Equipment Manufacturing (including household appliances, office machinery, parts and accessories)
11	**Electronic Equipment and Communication Apparatus Manufacturing**
1110	Electronic Components, Electronic Equipment and Communication Apparatus Manufacturing
1120	Audio and Video Equipment Manufacturing
12	**Automobile, Truck and Bus Manufacturing**
1210	Automobile, Truck and Bus Manufacturing
13	**Other Transportation Equipment and Vehicle Parts Manufacturing**
1310	Motor Vehicle Engine and Parts Manufacturing
1320	Ship and Boat Building (including repairing)
1330	Railroad Rolling Stock Manufacturing and Repairing
1340	Other Transportation Equipment Manufacturing
14	**Wood Sawing, Wood Products and Furniture Manufacturing**
1410	Wood Sawing and Wood Products Manufacturing
1420	Furniture Manufacturing
1430	Peat Production
15	**Paper Manufacturing, Publishing and Printing**
1510	Pulp and Paper Production
1520	Pulp, Paper and Paperboard Products Manufacturing
1530	Publishing and Printing
16	**Rubber Product Manufacturing**
1610	Rubber Product Manufacturing
17	**Non-petrochemical Chemical Manufacturing**
1710	Non-petrochemical Chemical Manufacturing

Nível 100	English description
1720	Alcohol Production
18	**Petroleum Refining and Petrochemical Manufacturing**
1810	Petroleum Refining
1820	Basic and Intermediate Petrochemical Manufacturing
1830	Resins, Artificial and Synthetic Fibers and Elastomers Manufacturing
19	**Miscellaneous Chemical Products Manufacturing**
1910	Fertilizer Manufacturing
1920	Miscellaneous Chemical Product Manufacturing
20	**Pharmaceutical Products, Perfumes and Detergents Manufacturing**
2010	Pharmaceutical Manufacturing
2020	Perfumes, Detergents and Candles Manufacturing
21	**Plastics Products Manufacturing**
2110	Laminated Plastics Plate and Pipe Manufacturing
2120	Plastics Products Manufacturing
22	**Textiles Manufacturing**
2210	Natural Fabric Processing, Weaving, Knitting and Finishing
2220	Artificial and Synthetic Fabric Weaving, Knitting and Coating
2230	Other Textiles Manufacturing
23	**Apparel and Apparel Accessories Manufacturing**
2310	Apparel and Apparel Accessories Manufacturing
24	**Footwear and Leather and Hide Products Manufacturing**
2410	Leather and Hide Products and Luggage Manufacturing
2420	Footwear Manufacturing
25	**Coffee Manufacturing**
2510	Coffee Manufacturing
26	**Plant Product Processing (including tobacco)**
2610	Rice Milling and Processing
2620	Wheat Milling

Nível 100	English description
2630	Fruit and Vegetable Processing and Canning (including juice and spices manufacturing)
2640	Other Grains and Seeds Milling and Plant Product Manufacturing
2650	Tobacco Product Manufacturing
27	**Slaughtering and Meat Processing**
2710	Animal (except poultry) Slaughtering and Meat Processing
2720	Poultry Slaughtering and Processing
28	**Fluid Milk and Dairy Product Manufacturing**
2810	Fluid Milk and Dairy Product Manufacturing
29	**Sugar Manufacturing**
2910	Sugar Manufacturing
30	**Seed Oil Refining and Food Fats and Oils Processing**
3010	Oilseed Milling
3020	Seed Oil Refining and Food Fats and Oils Processing
31	**Other Food and Beverage Manufacturing**
3110	Animal Feeds Manufacturing
3120	Other Food Manufacturing
3130	Beverage Manufacturing
32	**Miscellaneous Other Products Manufacturing**
3210	Miscellaneous Other Products Manufacturing

A.5 English descriptions of sectors at *Nível 80*

A list of *IBGE*'s English descriptions of sectors at *nível 80* is given below.

Nív.80	*Nív.50*	English Description of Sector
201	2	Iron ore mining
202	2	Mining of other metals
301	3	Oil and gas production
302	3	Coal and other mining
401	4	Non-metallic mineral products
501	5	Basic metallic products
502	5	Rolled steel
601	6	Non-ferrous metallic products
701	7	Other metallic products
801	8	Manufacturing and maintenance of machinery and equipment
802	8	Tractors and embankment machinery
1001	10	Electrical equipment
1101	11	Electronic equipment
1201	12	Automobiles, trucks, and buses
1301	13	Other vehicles and parts
1401	14	Timber and furniture
1501	15	Paper, pulp, and cardboard
1601	16	Rubber products
1701	17	Non-petrochemical chemical elements
1702	17	Alcohol
1801	18	Motor gasoline
1802	18	Fuel oil
1803	18	Other refinery products
1804	18	Basic petrochemical products
1805	18	Resins and fibers
1806	18	Alcoholic fuel
1901	19	Chemical fertilizers
1902	19	Paints, varnishes, and lacquers
1903	19	Other chemical products
2001	20	Pharmaceutical products and perfumes
2101	21	Plastics
2201	22	Natural textile fibers
2202	22	Natural textiles
2203	22	Artificial textile fibers
2204	22	Artificial textiles

Niv.80	*Niv.50*	English Description of Sector
2205	22	Other textile products
2301	23	Apparel
2401	24	Leather products and footwear
2501	25	Coffee products
2601	26	Processed rice
2602	26	Wheat flour
2603	26	Other processed edible products
2701	27	Meat
2702	27	Poultry
2801	28	Processed milk
2802	28	Other dairy products
2901	29	Sugar
3001	30	Raw vegetable oil
3002	30	Processed vegetable oil
3101	31	Animal food and other food products
3102	31	Beverages
3201	32	Miscellaneous

B Geographic Regions of Brazil

Firms are grouped by region. *PIA* follows the principle to list a firm in the region where the legal headquarters of the firm is located. This need not be the region where the firm creates most value. The following list gives an overview of the regions (variable `region`) and their codes, and the number of observations for each region and state (`uf`, *Unidade Federal*).

State	`uf`	Name	Valid Obs.[a]	Percent
`region` 1: North (*Norte*)			2,166[b]	2.75[b]
RO	11	*Rondônia*	253	.32
AC	12	*Acre*	63	.08
AM	13	*Amazonas*	839	1.47
RR	14	*Roraima*	0	.00
PA	15	*Pará*	956	1.22
AP	16	*Amapá*	35	.04
TO	17	*Tocantins*	17	.02

State	`uf`	Name	Valid Obs.[a]	Percent
`region` 2: North-East (*Nordeste*)			7,483[b]	9.51[b]
MA	21	*Maranhão*	455	.58
PI	22	*Piauí*	190	.24
CE	23	*Ceará*	1,331	1.69
RN	24	*Rio Grande do Norte*	561	.71
PB	25	*Paraíba*	523	.67
PE	26	*Pernambuco*	1,855	2.36
AL	27	*Alagoas*	460	.59
SE	28	*Sergipe*	321	.41
BA	29	*Bahia*	1,762	2.24
`region` 3: South-East (*Sudeste*)			50,117[b]	63.67[b]
MG	31	*Minas Gerais*	6,042	7.69
ES	32	*Espírito Santo*	956	1.22
RJ	33	*Rio de Janeiro*	6,753	8.59
SP	35	*São Paulo*	36,259	46.15
`region` 4: South (*Sul*)			17,084[b]	21.70[b]
PR	41	*Paraná*	4,821	6.14
SC	42	*Santa Catarina*	4,316	5.49
RS	43	*Rio Grande do Sul*	7,946	10.11
`region` 5: Center-West (*Centro-Oeste*)			1,863[b]	2.37[b]
MS	50	*Mato Grosso do Sul*	373	.47
MT	51	*Mato Grosso*	377	.48
GO	52	*Goías*	840	1.07
DF	53	*Distrito Federal*	264	.34
Subtotal			78,571	100.00
Unclassified			394	
Total			78,965	

[a] Observations with `catlife` equal to 9.3, 9.35, or 9.99 removed
[b] Observations for `region` are independent of `uf` (*Subtotal* of regions: 78,713).

C Categories of a Firm's 'Economic Curriculum'

This section presents fine rosters to classify firms according to their 'economic curriculum.' The first subsection C.1 is dedicated to categories of entry, whereas the second subsection C.2 deals with both the life (possible periods of suspended production) and the type of exit of a firm. The rosters are presented along with the algorithms to classify the firms in *PIA*. The categories are grouped according to four-digit arabic numbers, and more detailed instructions about applicable algorithms are given either with the definition of the category or in brackets.The algorithms mainly draw on the variables `state` and `change` and on whether a firm reports positive sales in a given year or not.

Useful additional pieces of information are the effective founding year of a firm (`effborn`, see section 2.6 and upper part of table 11) and whether a firm is continuously present in *PIA* or not. For the latter, an auxiliary variable called `contgrp` is created.`contgrp` was created.The variable `contgrp` takes four possible values

1: Continuous presence in all sample years

2: Continuous presence until apparently early exit from sample
[missing years at end of *PIA* only]

3: Continuous presence after apparently late entry into sample
[missing years at beginning of *PIA* only]

4: Interrupted presence [missing years at some other point]

Here, presence in a year means strictly positive sales in that year.

C.1 Categories of entry

Categories marked with an asterisk draw on information flowing from the 'family tree' of firms (see section 2.4). Conditions for higher-order groups apply to all lower-order groups.

1: Old firm that appears in *PIA* in 1986 or later
[`effborn` < 1986]

(2): New and 'well born' firm during sample period
[`effborn`=year of first appearance]

*2.1: Baby firm ('Greenfield creation')
[firm does not satisfy criteria for categories 2.2-2.5 of `catentr`]

*2.2: Creation as Legal Successor of existing firm (mere change of *tax number* or absorption by other firm)
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), and firm does not satisfy criteria for any of the following categories of `catentr`, 2.3-2.5]

*2.3: Creation through Merger of existing firms
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=1]

*2.4: Creation through complete Split-Up of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=4 or 5]

*2.5: Creation as Spin-Off of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=6]

3: Apparently new born firm in *PIA* (`state`=2 in *PIA*), but not reported in register
[`effborn` missing, but `state`=2 in first year of appearance]

(4): New born firm, but lag before appearance in *PIA* (lag of no more than 3 years)

(4.1): Lag of 1 year between registration in tax or *IBGE*'s register and first appearance in *PIA*
[`effborn` 1 year before first appearance]

*4.11: Baby firm
[firm does not satisfy criteria for any of the following categories of `catentr`, 4.12-4.15]

*4.12: Creation as Legal Successor of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), and firm does not satisfy criteria for any of the following categories of `catentr`, 4.13-4.15]

*4.13: Creation through Merger of existing firms
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=1]

*4.14: Creation through complete Split-Up of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=4 or 5]

*4.15: Creation as Spin-Off of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=6]

(4.2): Lag of 2 years between registration in tax or *IBGE*'s register and first appearance in *PIA*
[`effborn` 2 years before first appearance]

*4.21: Baby firm
[firm does not satisfy criteria for any of the following categories of `catentr`, 4.22-4.25]

*4.22: Creation as Legal Successor of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), and firm does not satisfy criteria for any of the following categories of `catentr`, 4.23-4.25]

*4.23: Creation through Merger of existing firms
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=1]

*4.24: Creation through complete Split-Up of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=4 or 5]

*4.25: Creation as Spin-Off of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=6]

(4.3): Lag of 3 years between registration in tax or *IBGE*'s register and first appearance in *PIA*
[`effborn` 3 years before first appearance]

*4.31: Baby firm
[firm does not satisfy criteria for any of the following categories of `catentr`, 4.32-4.35]

*4.32: Creation as Legal Successor of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), and firm does not satisfy criteria for any of the following categories of `catentr`, 4.33-4.35]

*4.33: Creation through Merger of existing firms
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=1]

*4.34: Creation through complete Split-Up of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=4 or 5]

*4.35: Creation as Spin-Off of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn` >=year of referencing), referencing 'parent' records `change`=6]

7: Late comer: Old firm that only appears in *PIA* later than 1986 (foundation

strictly more than three years earlier)
[`effborn` more than 3 years before first appearance]

(8): Out of the blue: Firm without age (no entry in tax or *IBGE*'s register) or birth
[`effborn` empty and `state`≠2]

*8.1: Truly out of the blue
[firm does not satisfy criteria for categories 8.2-8.5 of `catentr`]

*8.2: 'Family tree' allows classification as Legal Successor of existing firm
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), and firm does not satisfy criteria for any of the following categories of `catentr`, 8.3-8.5]

*8.3: 'Family tree' allows classification as Merger of existing firms
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=1]

*8.4: 'Family tree' allows classification as Successor from Split-Up
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=4 or 5]

*8.5: 'Family tree' allows classification as Successor from Spin-Off
[firm born after year of being referenced by 'parent' firm (`effborn`>=year of referencing), referencing 'parent' records `change`=6]

(9): Differently behaved firms

9.1: Firm enters like young (installation process), but is old according to tax or *IBGE*'s register
[`effborn` earlier than first appearance, but `state`=2 at first appearance]

9.2: Birth according to tax or *IBGE*'s register later than first appearance in *PIA*
[`effborn` later than first appearance]

9.3: Installation process observed after first appearance in *PIA*
[`state`=2 in a year strictly later than year of first appearance]

C.2 Categories of exit and suspended production

Categories marked with an asterisk draw on information flowing from the 'family tree' of firms (see section 2.4). Conditions for higher-order groups apply to all lower-order groups. Categories in curly brackets are never assigned by only listed here to clarify the classification system.

0: No exit, no period of suspended production, or missing sales observed after first appearance in sample
[both `state`<=2 and strictly positive sales in every year after first appearance (or `state`=2, 5 or 8 and `contgrp`=3)]

(1): Complete absorption by other firm
[`state`=4 or 6 (or `state`=8 and `change`=1, 2, 4, or 7; or `state`=1, `change`=10, and year=last year of appearance) and *tax number link* is set]

1.1: Change of legal status (inferred or from data)
[firm not `catlife`=1.2, 1.3, or 1.4, and successor born in year of referencing]

1.2: Merger [`change`=1]

1.3: Acquisition by existing firm
[firm not `catlife`=1.4 and successor born before referenced]

1.4: Delayed acquisition after complete suspension or exit
[at least one year with `state`=5, 6, or 8 and no sales after suspension period or exit, then acquisition by other firm]

2: Exit
[`state`=4 or 6 (or `state`=5 and year=last year of appearance; or `state`=8, `change` not set, no sales, and year is last year of appearance) and no *tax number link* set]

(3): Temporarily suspended production during sample period
[`state`=3 or 5 (or `state`=8, no sales, and `change`=8; or `state`=8, no sales, no successor, and `change` empty)]

3.0: No absorption or exit in any later period
[firm satisfies none of criteria for `catlife` 3.11-3.2]

3.11: Change of legal status in distant later period (at least 1 year of observed operation inbetween)
[firm satisfies criteria of `catlife` 1.1 otherwise]

3.12: Merger in distant later period (at least 1 year of observed operation inbetween)
[firm satisfies criteria of `catlife` 1.2 otherwise]

3.13: Acquisition by existing firm in distant later period period (at least 1 year of observed operation inbetween)
[firm satisfies criteria of `catlife` 1.3 otherwise]

3.14: Delayed acquisition in distant later period period after complete suspension (at least 1 year of observed operation inbetween)
[firm satisfies criteria of `catlife` 1.4 otherwise]

3.2: Exit in distant later period (at least 1 year of observed operation inbetween)
[firm satisfies criteria of `catlife` 2 otherwise]

(5): Missing data

5.0: Missing years
[Missing year(s) but firm satisfies none of criteria for `catlife` 5.1 through 5.3]

(5.1): Missing years before complete absorption by other firm (effective exit year adjusted accordingly)
[Missing year(s) before absorption. `state`=4 or 6 (or `state`=8 and `change`=1, 2, 4, or 7; or `state`=1, `change`=10, and year=last year of appearance) and *tax number link* is set]

5.11: Missing years immediately before change of legal status
[firm satisfies criteria of `catlife` 1.1 otherwise]

5.12: Missing years immediately before merger
[firm satisfies criteria of `catlife` 1.2 otherwise]

5.13: Missing years immediately before acquisition by existing firm
[firm satisfies criteria of `catlife` 1.3 or 5.5 otherwise]

5.14: Missing years immediately before ailing to delayed acquisition starts
[firm satisfies criteria of `catlife` 1.4 otherwise]

5.2: Missing years immediately before exit
[Missing year(s) before exit. `state`=4 or 6 (or `state`=5 and year=last year of appearance; or `state`=8, `change` not set, no sales, and year=last year of appearance) and no *tax number link* set]

(5.3): Missing years in neighboring year to period of suspended production (years imputed with `state`=9)
[Missing year(s) during period of suspended production and firm does not simultaneously satisfy criteria for `catlife` 5.1. In addition, `state`=3 or 5 (or `state`=8, no sales, and `change`=8; or `state`=8, no sales, no successor, and `change` empty)]

5.30: and no absorption or exit in any later period
[firm satisfies none of criteria for `catlife` 5.311-5.32]

5.311: and change of legal status in distant later period
[firm satisfies criteria of `catlife` 3.11 otherwise]

5.312: and merger in distant later period
[firm satisfies criteria of `catlife` 3.12 otherwise]

5.313: and acquisition in distant later period
[firm satisfies criteria of `catlife` 3.13 otherwise]

5.314: and delayed acquisition in distant later period
[firm satisfies criteria of `catlife` 3.14 otherwise]

5.32: and exit in distant later period
[firm satisfies criteria of `catlife` 3.2 otherwise]

5.5: Missing age of acquiring firm does not permit distinction of 1.1 and 1.3
[`state`=4 or 6 (or `state`=8, no sales, and `change`=1, 2, 4, or 7; or `state`=1, `change`=10, and year=last year of appearance) and *tax number link* is set; in addition, firm not `catlife`=1.2 or 1.4 and `effborn` not known for referenced successor firm]

(8): Not elsewhere categorized

8.0: Missing sales in at least one period, next best category 3.0
[in at least one year `state`=1 but no sales and no successor, and in every year `change` empty or `change`=10]

8.1: Combinations of `change`=10 and successor firm indicate possible name `change`, next best category 1.1
[firm does not satisfy criteria of any other `catlife` category in 1-5 or 9, `change`=10, and *tax number link* set (`state` may take any value)]

8.2: Combinations of `state`=8 and `change`=10 and no successor firm make firm fall through previous roster
[firm does not satisfy criteria of any other `catlife` category in 1-5, 8.0, 8.1 or 9, `state`=8, `change`=10, and *tax number link* not set]

8.3: Combinations of `state`=8 and `change`=? or `state`=? and `change`=10 make firm fall through previous roster
[firm does not satisfy criteria of any other `catlife` category in 1-5, 8.0-8.2 or 9, `state`=8, or `change`=10, or both]

8.7: Firm being non-industrial in at least one period (`state`=7) makes it fall through previous roster
[firm does not satisfy criteria of any other `catlife` category in 1-5, 8.0-8.3 or 9, and `state`=7 in at least one year]

(9): Contradictory or Problematic Exiting or Standstill Behavior

9.1: Firm is marked extinct but lives on or reappears
[`state`=4 or 6 (or `state`=8 and `change`=1, 2, 4, or 7) in some year, but strictly positive sales recorded in a later year]

*9.15: Firm may be put back to better category due to cross-referencing

9.2: Firm is marked as in built-up phase but was working before
[`state`=2 in some year but strictly positive sales in an earlier year]

9.3: Effective year of exit is year of first appearance in *PIA* or no sales ever [`effextyr`<=first year of appearance, or no strictly positive sales in any year]

*9.35: Firm may be put back to better category due to cross-referencing

9.99: Firm never found manufacturing in PIA
[firm does not satisfy criteria for `catlife`=9.3; and `state`>=5 in every year]

D Economic Variables in *PIA*

Table 16 documents the manner in which I construct consistent economic variables. The numbers in columns 3 through 5 indicate the 'id number' of the variables in the respective years of *PIA*. The 'id numbers' in columns 3 and 4 are precisely the numbers of the fields in the questionnaires of *PIA velha*. Due to the fact that two types of questionnaires exist in *PIA nova*, the id number in column 5 of table 16 is only equal to the field in the questionnaire when the id number is not preceded by an 'x'. The according translation from 'x'-ed variables into the id numbers in the long questionnaire (*questionário completo*) are given below table 16.

Some economic variables are inherently hard to deflate, such as liabilities. A simple way to use these variables but to avoid deflation problems is to express the liability structure through ratios. Similarly, social contributions and benefits may be hard to deflate, and it appears preferable to express their relation to total expenditures for personnel in ratios. Table 17 summarizes possible definitions for such ratios that are consistent over time. It also includes the ratio of foreign intermediate goods purchases per total intermediate goods purchases. This variable is reported in *PIA nova* since 1996.

Table 16: Economic Variables

Variable	Description	PIA 86-90	PIA 92-95	PIA 96-98[a]
`grssales`	Gross Sales of Final Goods	103	56	x15+16
`sales`	Net Sales of Final Goods	$109 \cdot \frac{103+105}{103+104+105}$	$62 \cdot \frac{56+58}{56+57+58}$	$\text{x14} \cdot \frac{\text{x15+16}}{14+15+16}$
`difstock`[b]	Change in Processed Goods Stocks	142	96	43-47+44-48
`resales`	Resales of Merchandise	104	57	15
`intmacq`[c]	Acquis. of Intermediate Goods	140	94	x26+58+63+71
`intmdif`[b]	Change in Interm. Goods Stocks	141	95	42-46
`labftot`	Labor (Total)	28	27	x01
`labftop`[d]	Labor Force: Top Management	24	24	x07
`labfwh`[d]	Labor Force: White-Collar	25	25	x05
`labfbl`	Labor Force: Blue-Collar	26	26	x03
`wagetot`	Salaries (Total)	33	32	x09
`wagetop`[d]	Salaries: Top Management	29	28	x12
`wagewh`[d]	Salaries: White-Collar	$30 + 32 \cdot \frac{30}{30+31}$	$29 + 31 \cdot \frac{29}{29+30}$	x11
`wagebl`	Salaries: Blue-Collar	$31 + 32 \cdot \frac{31}{30+31}$	$30 + 31 \cdot \frac{30}{29+30}$	x10
`astot`	Assets (Total)	11	11	.
`asliq`	Liquid Assets (in Total)	1	1	.

[a] Variables with a preceding 'x' indicate variables in *PIA nova* that have different names in questionnaires *quesionário completo* and *simplificado*. The x-variables correspond to the following variables in *questionário completo*: x01:=4, x03:=1, x05:=2, x07:=3, x09:=12, x10:=9, x11:=10, x12:=11, x14:=20, x15:=14, x26:=40.

[b] Initial stock less final stock.

[c] Includes electricity consumption and expenditure for equipment repair.

[d] Not strictly compatible between *PIA velha* (1986-95) and *PIA nova* (from 1996 on). Difference in classification of senior managers. See section 3.1.

Table 16: Economic Variables, continued

Variable	Description	PIA 86-90	PIA 92-95	PIA 96-98[a]
aslr	Long-run Assets (in Total)	6	6	.
aspsum	Permanent Assets (Sum; in Long-run A.)	7	7	.
aspinv	Perm A.: Holdings of Investments	8	8	.
aspimmo	Perm A.: Equipment & Real Estate	9	9	.
aspmasum	Perm A.: Machinery (in Eq.&R.Est.)	97	.	.
aspdefer	Perm A.: R&D & Fiscal Operations	10	10	.
asrtimmo	Rental of Equipment & Real Est.	132	86	x36
aslsimmo	Leasing of Equipment	133	87	x37
deprec	Asset Depreciation Cost	135	89	61
fincost[b]	Financial Costs	117	70	67+68-28
acqtot	Acquisitions of Assets (Total)	56	47	80+85+x53
acqbl	Acquisition of Ground & Premises	42+43	33+34	x55+x59+x63
acqmasum	Acquisitions of Machinery (Sum)	46	37	x56+x60+x64
acqmadom	Acquis. of Machinery: Domestic	47	38	.
acqmause	Acquis. of Machinery: Used	49	40	.
acqmafor	Acquis. of Machinery: Foreign	48	39	.
acqveh	Acquisitions of Vehicles	50	41	x57+x61+x65
acqother	Acquisitions of Other Assets	53+54+55	44+45+46	x58+x62+x66
acqcomp	Acquis. of Other Ass.: Computers	54	45	.

[a]Variables with a preceding 'x' indicate variables in *PIA nova* that have different names in questionnaires *quesionário completo* and *simplificado*. The x-variables correspond to the following variables in *questionário completo*: x36:=59, x37:=60, x53:=90, x55:=76, x56:=77, x57:=78, x58:=79, x59:=81, x60:=82, x61:=83, x62:=84, x63:=86, x64:=87, x65:=88, x66:=89.

[b]Includes costs and benefits from monetary correction.

Table 16: Economic Variables, continued

Variable	Description	PIA 86-90	PIA 92-95	PIA 96-98[a]
asltot	Sales of Assets (Total)	72	55	x54
aslbl	Sales of Ground & Premises	65+66	48+49	x67
aslmasum	Sales of Machinery	67	50	x68
aslveh	Sales of Vehicles	68	51	x69
aslother	Sales of Other Assets	69+70+71	52+53+54	x70
aslcomp	Sales of Other Ass.: Computers	70	53	.
balsum[b]	Total Liabilities	23	23	.
crtot[c]	Credit (Total)	12+17	12+17	.
crstsum[d]	Short-Term Credit (Sum)	12	12	.
crstdom[d]	Short-Term Credit: Domestic	14	14	.
crstfor[d]	Short-Term Credit: Foreign	15	15	.
crltsum[d]	Long-Term Credit (Sum)	17	17	.
crltdom[d]	Long-Term Credit: Domestic	18	18	.
crltfor[d]	Long-Term Credit: Foreign	19	19	.
profit[e]	Profit before tax	126-127+124+125	80-81+77+78+79	74-75

[a]Variables with a preceding 'x' indicate variables in *PIA nova* that have different names in the questionnaires *quesionário completo* and *simplificado*. The x-variables correspond to the following variables in *questionário completo*: x54:=95, x67:=91, x68:=92, x69:=93, x70:=94.

[b]Since asset revaluations affect equity, this variable is extremely hard to value. It is therefore only used in ratios. See table 17.

[c]Industry-wide prices indices within the *IPA-OG* or *IGP-DI* series or economy-wide price indices may arguably be adequate deflators.

[d]Reliable deflation methods remain to be developed. This variable is used in ratios only. See table 17.

[e]The proposed figure is not strictly compatible before and after 1990. Social contributions under *lei 7689 de 15/12/1988* reduce the profits in addition to the tax payments from 1989 on. This fact is only accounted for after 1991. So, the years 1989 and 1990 are not strictly consistent with the other years. Also see section 3.1 on this.

Table 17: Ratios of Economic Variables

Variable	Description	PIA 86-90	PIA 92-95	PIA 96-98[a]
`crrat`	Ratio: Credit in Balance Sum	(12+17)/23	(12+17)/23	.
`crltrat`	Ratio: Long-Term Cr./Tot. Credit	17/(12+17)	17/(12+17)	.
`crforrat`	Ratio: Foreign Cr./Total Credit	(15+19)/(12+17)	(15+19)/(12+17)	.
`crstfrat`	Ratio: Foreign Short-Tm./STm Cr.	15/12	15/12	.
`crltfrat`	Ratio: Foreign Long-Term/LTm Cr.	19/17	19/17	.
`deprcrat`	Ratio: Depreciation/Total Cost	135/ *Total Cost*[b]	89/ *Total Cost*[c]	61/(x33-x41)
`finexrat`[d]	Ratio: Financial Cost/Total Cost	117/ *Total Cost*[b]	70/ *Total Cost*[c]	(67+68-28)/(x33-x41)
`sallcrat`	Ratio: Salaries/Total Labor Cost	$\frac{128+129}{128+129+130+131}$	$\frac{82+83}{82+83+84+85}$	x43/x42
`soclcrat`[e]	Ratio: Soc.Contrib./Tot.Lab.Cost	$\frac{130}{128+129+130+131}$	$\frac{84}{82+83+84+85}$	$\frac{x44+x45+x46+x47}{x42}$
`benlcrat`[f]	Ratio: Benefits/Total Labor Cost	$\frac{131}{128+129+130+131}$	$\frac{85}{82+83+84+85}$	x48/x42
`labtcrat`	Ratio: Labor Cost/Total Cost	$\frac{128+129+130+131}{Total\ Cost}$[g]	$\frac{82+83+84+85}{Total\ Cost}$[h]	x42/(x42+x33-x41)
`intfrrat`	Ratio: Foreign Intm./Tot. Intm.	.	.	51[i]

[a] Variables with a preceding '*x*' indicate variables in *PIA nova* that have different names in questionnaires *quesionário completo* and *simplificado*. The *x*-variables correspond to the following variables in *questionário completo*: x33:=73, x41:=72, x42:=39, x43:=33, x44:=34, x45:=35, x46:=36, x47:=37, x48:=38.

[b] *Total Cost*: 119+132+133+134+135+138+139+140. 117 not included to avoid double count.

[c] *Total Cost*: 72+86+87+88+89+92+93+94. 70 not included to avoid double count.

[d] Includes costs and benefits from monetary correction.

[e] Social contributions include payments to the federal Brazilian social security system, to private pension funds, to health insurances and care providers.

[f] Benefits include: Transport, board, educational programs, day nurseries, and the like.

[g] *Total Cost*: 119+128+129+130+131+132+133+134+135+138+139+140. 117 not included to avoid double count.

[h] *Total Cost*: 72+82+83+84+85+86+87+88+89+92+93+94. 70 not included to avoid double count.

[i] Named *PERCEST*. Original figure is percentage.

References

Aw, Bee Yan, Sukkyun Chung, and Mark J. Roberts, "Productivity and Turnover in the Export Market: Micro-level Evidence from the Republic of Korea and Taiwan (China)," *World Bank Economic Review*, January 2000, *14* (1), 65–90.

Clerides, Sofronis K., Saul Lach, and James R. Tybout, "Is Learning by Exporting Important? Micro-dynamic Evidence from Colombia, Mexico, and Morocco," *Quarterly Journal of Economics*, August 1998, *113* (3), 903–47.

Griliches, Zvi and Haim Regev, "Firm Productivity in Israeli Industry, 1979-1988," *Journal of Econometrics*, January 1995, *65* (1), 175–203.

IBGE, *Pesquisa Industrial Anual, Coleta Complementar: Manual de Treinamento* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1986.

___ , *Pesquisa Industrial Anual, Coleta Especial: Manual do Agente* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1986.

___ , *Estatísticas Históricas do Brasil. Séries Econômicas, Demográficas e Sociais, 1550-1988*, 2 ed., Vol. 3 of *Séries Estatísticas Retrospectivas*, Rio de Janeiro: Fundação Instituto Brasileiro de Geografia e Estatística, 1990.

___ , *Pesquisa Industrial Anual: Instruções de Preenchimento do Questionário PIA - 0.01 Empresa* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1992.

___ , *Pesquisa Industrial Anual: Manual do Técnico de Pesquisa* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1994.

___ , *Pesquisa Industrial Anual: Instruções para o Preenchimento do Questionário Completo de Empresa e Unidades Locais* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1996.

___ , *Pesquisa Industrial Anual: Manual do Técnico de Pesquisas* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1996.

___ , *Pesquisa Industrial Anual: Instruções para o Preenchimento do Questionário Simplificado* Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Diretoria de Pesquisas (DPE), Departamento de Indústria (DEIND), Rio de Janeiro: Secretaria de Planejamento e Coordenação da Presidência da República, 1997.

IOB, "Imposto de Renda e Legislação Societária," in "Boletim IOB," Vol. 38/94, Brasília: IOB (Informações Objetivas), 1994, pp. 464–466.

___ , "Imposto de Renda e Legislação Societária," in "Boletim IOB," Vol. 45/96, Brasília: IOB (Informações Objetivas), 1996, pp. 554–561.

___ , "Tabelas de Índices de Preços," in "Calendário Objetivo de Obrigações e Tabelas Práticas," Vol. Decembro de 2000, Brasília: IOB (Informações Objetivas), 2000, pp. 85–89.

Levinsohn, James, "Testing the Imports-as-Market-Discipline Hypothesis," *Journal of International Economics*, August 1993, *35* (1-2), 1–22.

Muendler, Marc-Andreas, "Definitions of Brazilian Mining and Manufacturing Sectors and Their Conversion," September 2002. University of California, San Diego, Mimeograph.

___ , "Foreign Producer Price Indices corresponding to Brazilian Manufacturing Sectors, 1986-2003," November 2003. University of California, San Diego, Mimeograph.

___ , "Productivity Estimation When Efficiency Choice Is Endogenous," November 2003. University of California, San Diego, Mimeograph.

___ , "Trade, Technology, and Productivity: A Study of Brazilian Manufacturers, 1986-1998," September 2003. University of California, San Diego, Mimeograph.

Roberts, Mark J. and James R. Tybout, eds, *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity, and Market Structure*, Oxford: Oxford University Press for the World Bank, 1996.

Rodrigues, Agostinho Inácio, Edilton Pereira da Silva, and Sidney Ferro Barros, *A Nova Correção Monetária do Balanço: Lei n. 8200 de 28-6-91 Regulamentada pelo Decreto n. 332 de 4-11-91*, Brasília: IOB (Informações Objetivas), 1992.