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ORIGINAL PAPER

The role of demographics in precipitating economic downturns

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Abstract There are significant effects of changing demographics on economic indicators: not only growth in GDP but also the current account balance and gross capital formation. The 15–24 age group is one of the key age groups in these effects, with increases in that age group exerting strong positive effects on GDP growth, and negative effects on the CAB and GCF. There have been major shifts in the share of the population aged 15–24 during the past half century or more, and 80% of these globally coincide with declines in GDP growth. This appears to have been the pattern in four financial crises since 1980 as well as Japan's "lost decade." The effect is even more pronounced for the 2008–2009 period.

Keywords Age structure · Recession · Depression

JEL Classification J1 · E3 · F4

The intention in this paper is to describe an empirical regularity concerning changes in the age structure of the population—specifically changes affecting those portions of a country's population most responsible, on a per capita basis, for growth in aggregate demand. Historically, in many instances when countries have experienced economic downturns, there has been a previous reversal in the rate of growth of those segments of the population, across a number of countries affected by the crises. These economic slowdowns may be qualitatively different from those associated with a normal business cycle. If

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so, it might suggest an early warning signal provided by demographic structure established some decades earlier.

The plan in this paper is first to consider the possible role of slowdowns in the growth of aggregate demand, in triggering crises in financial institutions (Section 1); set out the demographic argument central to this paper (Section 2); discuss the potential significance of demographics in economic activity generally (Section 3); explore empirically the relationship between demographics and indicators of economic activity (Section 4); and then finally to illustrate the type of demographic changes that have occurred simultaneously with economic reversals, using the 2008–2009 episode as an example (Section 5).

1 The role of aggregate demand in institutional crises

In 1997 and 1998, the "Asian Tigers"—Indonesia, Korea, Malaysia, the Philippines, and Thailand—experienced a sharp drop in the value of their currencies and a reversal of private capital flows from abroad. Whereas foreign investors had been pouring massive amounts of capital into these countries prior to 1997, they began to withdraw funds at an even faster rate after June of 1997, severely depressing economic indicators and even in some cases creating political turmoil. There was a similar type of occurrence among Latin American countries earlier in the 1990s (often referred to as the "Tequila" crisis) and in Chile in 1982. And of course, we have seen the recent economic crisis of 2008–2009. The literature abounds with analyses and models put forward to explain these phenomena, but all of them tend to focus on financial and policy aspects of the upheavals, without seeming to consider whether the episodes might have been demand driven. The words "population" and "demographics" are conspicuously absent from the literature.

It is possible to insert demographics into the various models without actually altering them. We just need to recognize the demographic factors at work behind the mechanisms outlined in those models. To see this, we need to consider the two primary models which have emerged from the literature. The first focuses on macroeconomic fundamentals, such as the current account balance, international capital flows, the exchange rate and interest rates, and finds unsustainable imbalances and problematic government policies. This model sees a central bank attempting to defend its exchange rate—and thus drawing down its foreign reserves—while at the same time finding it necessary to shore up and then ultimately bail out banks and other financial institutions that begin failing under the pressure of increasing numbers of non-performing loans—loans which had been made at breakneck rates in the previous years. Speculators attack the currency, and foreign investors call in loans, in anticipation of an exchange rate devaluation. This is what occurs in a country

> Whose private sector is subject to a series of shocks that threaten corporate and banking profitability. These financial difficulties may require the government to bail out troubled institutions...Agents observing the

weaknesses of the private sector can see that the government will be forced to adopt an expansionary monetary stance in the future to finance the costs of bailout intervention. Since such expansion is inconsistent with maintaining the exchange rate peg, investors will expect the currency to depreciate, and this expectation will trigger a speculative attack. (Pesenti and Tille 2000:4–5)

The second model is closely related—so much so that Pesenti and Tille (2000) argue that the two are actually complementary—but focuses on the role of speculators in creating a self-fulfilling crisis. That is, in anticipation of a possible exchange rate devaluation, speculators unload the local currency, thus drawing down foreign reserves and ultimately forcing the government to actually devalue. Pesenti and Tille present a model of contagion in which

A currency depreciation in one country weakens fundamentals in other countries by reducing the competitiveness of their exports...initial turmoil in one country can lead outside creditors to recall their loans elsewhere.
...a currency crisis in one country can worsen market participants' perception of economic outlook in countries with similar characteristics.

And this idea of contagion can also apply within a country, spreading the effects of bankruptcy:

Debt rollover difficulties, even when located in one sector of the economy, can spill over the whole economy and result in vanishing credit and a major welfare loss. (Calvo 2000:91)

However, as Calvo (2000) points out, none of the models explain why the crises happened *when they did*:

Without question, there were macroeconomic imbalances, weak financial institutions, widespread corruption, and inadequate legal foundations in each of the affected countries. These problems needed attention and correction, and they clearly contributed to the vulnerability of the Asian economies. However, most of these problems had been well known for years...(Calvo 2000:150)

The focus here is on those bankruptcies and non-performing loans mentioned earlier. They could well be the result of a slowing economy: investors who had counted on continuing economic growth to generate revenues, are caught when growth slows and revenue streams fall short of those anticipated. Similarly, in the case of the 1996–98 crisis, "[c]ontinuing and in some cases increasing, high economic growth gave confidence to foreign investors" (Calvo 2000:117) prior to 1997—but seeing revenue streams drying up with a slowdown, they withdrew their funds.

2 The argument put forward in this paper

The assumption in this paper is that the slowdown led to the bankruptcies and subsequent lack of confidence among investors—and that the slowdown itself was generated at least in part by demographic changes. The argument hinges on the notion that a significant portion of the growth in demand in the economy comes from new household formation. Some of this new household formation will result from immigration, but the vast majority of it results from young adults leaving their parents' homes and forming their own households. They generate demand for housing and consumer durables including automobiles, in addition to causing large expenditures on education. If there is growth in this segment of the population, there will be overall growth in consumption, and similarly rates of growth in consumption will fall with declines in the growth rate of this significant group.

This group's expenditures do not appear significant in Consumer Expenditure Surveys (CES) such as those conducted by the Bureau of Labor Statistics in the USA, but shelter costs are represented there only in terms of interest or rental payments, not total expenditure. (Expenditures on house purchase appear as changes in total assets and liabilities.) Thus, the actual total expenditure generated in the economy by the age group in providing new housing units—whether rental or owned—is not represented as expenditure in the CES. This effect is magnified by the fact that a good deal of expenditure on cars, housing, and furnishings for the group is often made by parents and reported as expenditure by the parental age group rather than by the target age group. The only way to see the total impact of this or any age group is to analyze econometrically the relationship between the growth in various age group shares, and growth in GDP per capita.

3 The role of demographics in economic activity

An earlier study (Macunovich 2007) demonstrated a strong age-related pattern of consumption using state-level personal consumption expenditure data, and population by single year of age, for the US from 1900 through 1987. That work suggested that the passage of the US baby boom from childhood through the teen years and into family formation caused marked swings in patterns of aggregate consumption demand in the USA during the second half of the twentieth century. Applying that study's estimated age-group effects to time trends of national US population age structure suggested that, holding other factors constant (including income and total population size), the baby boom-generated changes in age structure accounted for swings of about 25% in total real aggregate personal consumption demand.

Similarly, Fair and Dominguez (1991) found significant effects of detailed age structure in the adult population, on all forms of consumption demand in the USA, including housing demand, and on the demand for money.

A strong differential effect of specific age groups on economic performance has also been demonstrated in the work of Jeffrey Williamson and his colleagues, using the "Asian Tigers" and also the pre-1914 Atlantic economy.[1] They have shown that the proportion of children relative to working age adults has dramatic effects on savings rates and the demand for capital—and hence on foreign capital dependence. Like the findings in Macunovich (2007), but unlike those of Fair and Dominguez (who looked only at age structure among adults), the work of Williamson and colleagues addressed distributional effects using detailed age breakdowns throughout the entire age structure, including children, finding a negative effect of population growth per se, but a positive effect of the proportion of the population in the prime working ages. They attribute much of the "Asian miracle"—and of pre-1914 growth in the Western world—to the entry into prime working ages of these countries' "baby boomers"—the population swell produced during their respective demographic transitions.

Four other papers look at the effect of changing age structure on economic growth as well. Della Vigna and Pollet (2007) find a strong effect on industry portfolio returns based on long-term growth due to demographics. Feyrer (2007, 2008) examines the effect of demographics on productivity and output per worker, finding a strong positive effect of the 40–49 age group (but looking only at workers aged 10–69, rather than at the entire population). Bloom and Finlay (2009), in turn, demonstrate a strong effect of the working age (15–64) population on economic growth, in terms of income per capita, in thirteen South and East Asian nations.

Much of the work to date gives credit to changing population age structure, in generating strong economic growth. But although these researchers allude to growth slowdowns as populations age, they do not seem to address the potential for economic turmoil created by the transition from high to low growth in specific age groups. This is probably because to a great extent their models attribute growth to the entire working-age population—the 15–64 age group—and any transition in such a large age group's population share would be very gradual: barely discernable on a year-to-year basis.

Given the fact that they are forming new households, it seems that changes in the size of the young adult age group—say, approximately from age 15 to 24—will have a very different effect on the economy than, say, changes in the numbers of 55–64-year-olds, who are simply existing households passing from one age group to another. To the extent that this is the case, when the 15–24 age group's share of population begins to decline, producers will be hit with an unexpected drop in the growth of demand for their products, leading to inventory build-ups and production cutbacks—as alluded to by Keynes:

> An increasing population has a very important influence on the demand for capital. Not only does the demand for capital—apart from technical changes and an improved standard of life—increase more or less in

[1] Bloom and Williamson (1998), Higgins and Williamson (1997) and Higgins (1998).

> proportion to population. But, business **expectations** being based much more on present than prospective demand, an era of increasing population tends to promote optimism, since demand will in general tend to exceed, rather than fall short of, what was **hoped for**. Moreover a mistake, resulting in a particular type of capital being in temporary over-supply, is in such conditions rapidly corrected. But in an era of declining population the opposite is true. Demand tends to be below what was **expected**, and a state of over-supply is less easily corrected. Thus a pessimistic atmosphere may ensue; and, although at long last pessimism may tend to correct itself through its effect on supply, the first result to prosperity of a **changeover** from an increasing to a declining population may be very disastrous. (John Maynard Keynes 1937, emphasis added)

Through a chain reaction of similar types of cutback the economy may tailspin into an economic slump—as suggested by J.K. Galbraith (1958).

This is not to say that decline in the young adult age group in and of itself is harmful for an economy: many have argued eloquently against such a notion, even in the case of population decline generally.[2] Rather, it is the *turning point* from rising to falling proportions of young adults that appears to pose a potential threat to economic stability, and "unexpected" is the key word in the previous paragraph—again as suggested by Keynes above. Producers can in time accommodate themselves to decline, as long as it's expected: it is the unexpected that occurs at turning points, which "may be very disastrous."

The extent of any institutional turmoil induced by such turning points is undoubtedly a function of many factors in addition to changes in population age structure—most notably, the integrity of the banking system, and the financial sector generally, and the ability of the public sector to prevent escalation. Schumpeter (1946) attributed the virulence of the 1929 crash to "... supernormal sensitivity of the economic system to adverse occurrences and... the weaknesses in the institutional setup." As international trade has grown and strengthened, the integrity and stability of trade partners has become significant, as well.

Thus it could be that a relatively small change in the growth rate of the young adult age group in the USA in 1929, when financial systems were less robust, and major trading partners experienced more severe declines, had significantly greater effects than a much larger change in age structure in 1973, when monetary and fiscal policies of the government had a more stabilizing influence and most trade partners had not yet experienced any decline. Unforeseen changes in population age structure have the potential for triggering catastrophic institutional turmoil—and virtually always appear to cause at least a degree of economic dislocation.

There appears to be evidence that this process has been at work in the USA over the past 100 years, as demonstrated in Fig. 1. The curve on the graph

[2]See, for example, Easterlin (1996).

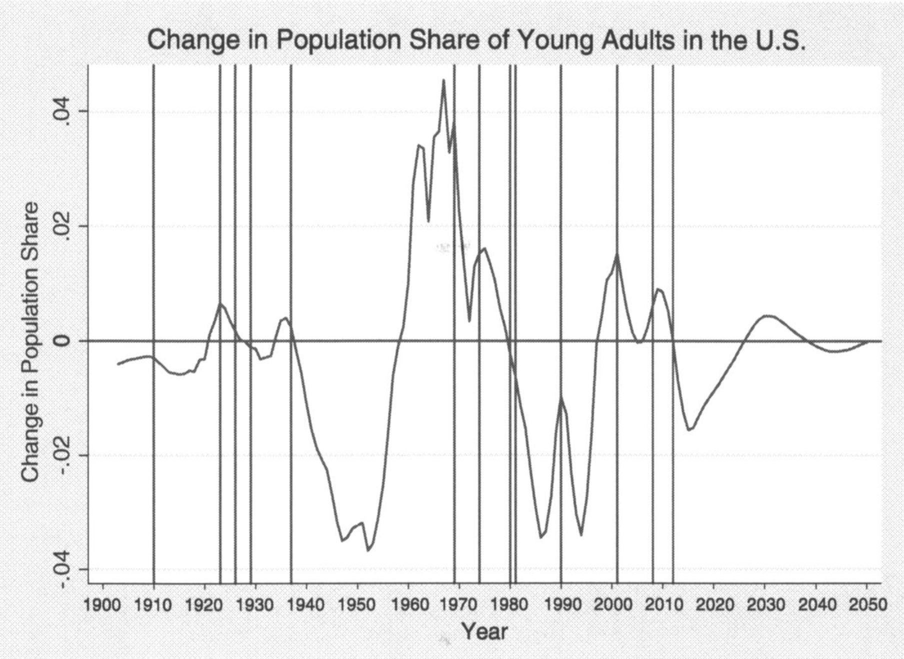

Fig. 1 The *curve* on the graph represents a 3-year moving average of the (1 year) lagged annual rate of change in the proportion of young adults in the US population, as reported by the US Census Bureau. "Young adults" are defined as those aged 15–19 prior to 1950, and 20–24 in the years after, given changing levels of education over time. The *vertical lines* mark the start of recessions, as defined by NBER

represents the annual rate of change in the proportion of young adults in the US population. "Young adults" are defined as those aged 15–19 prior to 1950 and 20–24 in the years thereafter, given changing levels of educational attainment over time. The vertical lines mark the start of recessions, as defined by NBER. There is a very close correspondence between the vertical lines, and peaks in the curve, as well as points where the curve goes negative. In addition, the deep trough between 1937 and 1958 contained another four recessions, and there were two in the trough between 1910 and 1920 (not marked on the graph). The only recessions over the last 100 years that do not appear to correspond to features of the curve are those in 1920, 1926, and 1960.

The pattern of causation—if it is one—cannot for the most part run from the economy to demographics, since these are young people born over 15 years before each economic downturn. To control for the possibility that the size of the young adult age group might be affected by economically induced migration, lagged values of age shares have been used. That is, the graph actually shows the pattern of change in the 14–18- and 19–23-year age groups, 1 year earlier (the pattern is virtually unchanged from that obtained using unlagged values).

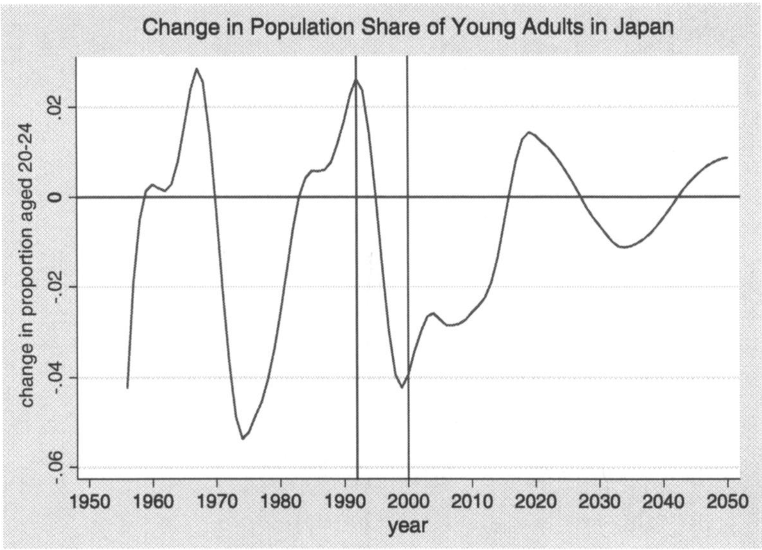

Fig. 2 The *curve* on this graph indicates annual rates of change in the (5-year) lagged proportion aged 15–24 in Japan's population. The *vertical lines* indicate the period that has generally been referred to as Japan's "lost decade," beginning with its financial crisis in 1992

A similar type of relationship is presented for Japan in Fig. 2 (again using lagged values to instrument the actual rates of change). There, it can be seen that Japan experienced a substantial drop in the growth rate of the 20–24 age group during the period now referred to as its "lost decade."

4 The analysis

The goal of this analysis was to test for a significant relationship between macroeconomic variables and population age shares, at both the national and the international level. The economic data were taken from an unbalanced panel for approximately 155 countries in the period 1960 through 2004/5, prepared by the World Bank (2007): annual growth rate of GDP per capita (GDPpc), the Current Account Balance as a percent of GDP (CAB), and Gross Capital Formation as a percent of GDP (GCF). All of the regressions were estimated using Stata's cross-sectional time series "xtreg" procedure, with fixed effects.

Rates of growth in population age shares for all countries except the USA were calculated from data prepared by the UN (1999), which provides population in five year age groups for approximately 170 countries from 1950–2000, with forecasts to 2050. The US data are for single year age groups, 1900–1995 and forecast to 2050, provided on diskette by the US Bureau of the Census (1996). Although age groups other than the 0–4 are in large part predetermined in any current time period, as births which occurred in earlier periods, there is some possibility of endogeneity in the sense that current economic conditions might induce immigration or emigration. For this reason, lagged values of the population variables have been used in all analyses presented in this paper. For example, the change in the share aged 15–24 in a given year is instrumented using the change in the share of the same cohort 5 years earlier (that is, the change in the 10–19 age group 5 years earlier).

It is important, in such an analysis, to work with fairly small age groupings—to divide the population into a fairly large number of age groups—in order to allow for effects which may vary significantly, even between age groups that are fairly close (think, for example, of 0–4-year-olds as compared with 10–14-year-olds. These are typically lumped together in the "dependent" 0–14 age group, and yet their own behavior—and parental spending on the two groups—can vary significantly).

Ideally, a large number of age groups would be separately identified as independent variables in the analysis to avoid this age group identification problem. But a model that includes a large number of age groups might encounter a problem of severe multicollinearity that calls into question the accuracy of any individual coefficient estimates. And problems of multicollinearity are compounded by the marked loss of degrees of freedom in estimating those coefficients, as the number of age groups is increased—an important consideration in time series analyses. As observed by David (1962), "Age varies continuously and there are few convenient demarcations between age groups with significantly different behavior patterns." Thus, we face a conundrum: construct "artificial" and possibly erroneous age groupings, or face the possibility of severe multicollinearity among more finely disaggregated groupings.

In the first stage of the analysis, in order to minimize problems associated with the identification of "homogeneous" age groups within the population, detailed age breakdowns of the total population were used, in a method first implemented by Fair and Dominguez (1991), and used in later analyses by Higgins and Williamson (1997) and Higgins (1998).[3] The Fair–Dominguez method of parameterizing multiple age groups is based on the distributed lag technique of Almon (1965). In general terms, it is one that permits the estimation of coefficients on single year population age shares by constraining those coefficients to lie along a polynomial. The coefficients ϕ_j on J population age shares p_j are assumed to enter the consumption equation in the form

$$\sum_{j=1}^{J} \varphi_j p_j \qquad (1)$$

[3]It must be emphasized that the inclusion of the full age distribution—including infants and children—in a more aggregated model does not in any way imply or necessitate decision-making on the part of children themselves, with regard to their patterns of consumption. It simply allows for the fact that children in one household might affect the spending patterns of individuals in other age groups and/or households.

which is estimated as a polynomial

$$\sum_{j=1}^{J} \varphi_j p_j = \varsigma_1 Z_1 + \varsigma_2 Z_2 + \ldots + \varsigma_n Z_n \tag{2}$$

in which n is the degree of the polynomial and

$$Z_n = \sum_{j=1}^{J} p_j j^n - 1/J \sum_{j=1}^{J} p_j \sum_{j=1}^{J} j^n \tag{3}$$

Each Z that results from this procedure is essentially a summation of weighted population age shares. In the first variable, Z_1, the age weights are raised to the first power, while in Z_2, they are squared, and then in Z_3, they are cubed, and so on. In the regression results, the estimated coefficients on the individual population age shares can be easily recovered from the coefficients estimated for the Zs.[4]

Determining the degree of the polynomial, n—the number of these population age Zs to include as explanatory variables—appears in earlier studies to have been based largely on economic theory, assuming a quadratic at the aggregate level based on the hypothesized life cycle "hump-shaped" pattern at the micro level (that is, using just two Zs, Z_1 and Z_2). But as emphasized earlier in this paper, because of inter-household effects, a different pattern may emerge at the aggregate level, and this pattern might vary across cultures, depending on, for example, the role of children in society, the age at which young people leave their parents' homes and whether the government provides any form of financial support in old age.

There is more danger in under- than in over-estimating the degree of the polynomial. Judge et al. (1985:359–60) state that while overestimates of the true degree of the polynomial produce estimators that are unbiased but inefficient, underestimates of the true degree produce estimates that are "always biased." For this reason, they suggest starting with a higher level than is assumed to apply in the true model and stepping down, testing each additional restriction and finally accepting the level that "produces *the last acceptable hypothesis* [their italics]." That procedure has been adopted in this study, beginning with $n = 9$ and working down until a regression produces significant coefficients on the highest Z amalgams.

This technique was applied to four groups of countries:

All countries taken together

The "Asian Tigers" that experienced a financial crisis in the 1996–98 period: Korea, Indonesia, Malaysia, Philippines, and Thailand

The "Tequila Group" that experienced a financial crisis in the 1992–1994 period: Mexico. Brazil, Argentina, Colombia, and Peru

The USA and Japan

[4]For a more complete description of the derivation of the model, please see the appendix in Macunovich (2009).

Table 1 GLS fixed-effects regressions of growth in per capita GDP on lagged vectors of changes in population age shares

	All countries	Asian Tigers	Tequila group	USA and Japan
# of obs	5,671	225	224	90
# of countries	155	5	5	2
R^2				
Within	0.0758	0.6136	0.3702	0.5067
Between	0.0109	0.3942	0.2545	1.0000
Overall	0.0694	0.4804	0.3676	0.0197
Z_1	−0.0257 (−2.25)	−0.0054 (−0.26)	0.0088 (1.38)	−0.1788 (−3.10)
Z_2	0.0051 (3.50)	0.0017 (0.77)	−0.0002 (−1.46)	0.0266 (3.33)
Z_3	−0.0004 (−4.35)	−0.0001 (−1.06)	1.91e-06 (1.44)	−0.0017 (−3.38)
Z_4	1.31e-05 (4.96)	2.85e-06 (1.24)		5.36e-05 (3.38)
Z_5	−2.38e-07 (−5.43)	−3.36e-08 (−1.37)		−9.17e-07 (−3.34)
Z_6	2.16e-09 (5.79)	1.47e-10 (1.45)		7.95e-09 (3.27)
Z_7	−7.76E-12 (−6.07)			−2.74e-11 (−3.20)
Year dummies?	Yes	Yes	Yes	No[a]
Constant	0.025 (4.25)	0.049 (3.11)	0.030 (1.39)	0.249 (1.65)

t Statistics in parentheses; lagged values are used to control for possible endogeneity in the demographic variables. Age shares are lagged by using the pattern for the age group 5 years younger, 5 years earlier

[a]The 45-year dummies were omitted from the last regression because of the small number of observations

In this way, it was determined that $n = 6$ for the "Asian Tigers" regression, $n = 3$ for the Tequila Group, and $n = 7$ for the other two groups. Table 1 and Fig. 3 present the results of this first stage of the analysis, using the Fair–Dominguez methodology.

Table 1 presents the results of regressing the rate of growth in per capita GDP on lagged rates of growth in population age shares, as represented using the Zs. There, it can be seen that all coefficients are significant for "All Countries" and for the USA and Japan, while the highest Zs are significant at about the 0.15 level for the Asian Tigers and the Tequila Group. In Fig. 3, the age share coefficients have been recovered from the coefficients on the Zs and are displayed for each of the four country groups.

Although at first glance, the shapes in the four graphs in Fig. 3 might appear quite different, upon closer examination, it can be seen that there is a striking similarity among the four, in terms of the effect of children under 15 (negative), and young adults aged 15–24 (positive—marked by the two vertical bars). In addition, there is also a positive effect of middle-aged groups in all but the Tequila Group, where the third-degree polynomial of the regression does not permit a finer demarcation of age groups. The positive effect of the middle-aged groups is consistent with findings in studies mentioned earlier.[5] These earlier studies do not specifically examine the 15–24 age group, however. The significant positive effect of the 15–24 age group estimated here is consistent

[5]Bloom and Williamson (1998), Higgins and Williamson (1997), Higgins (1998), Feyrer (2007, 2008), and Bloom and Finlay (2009).

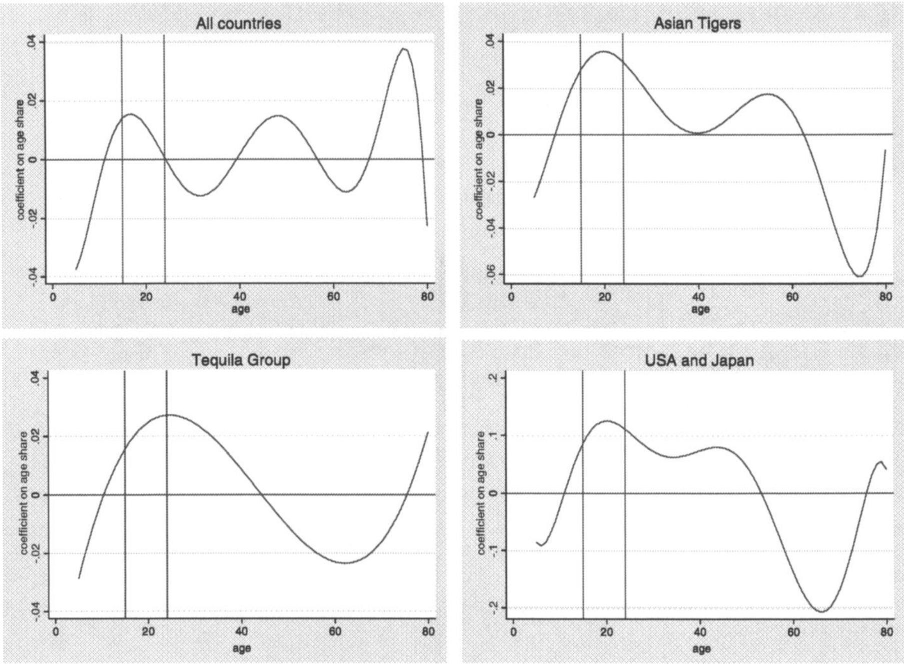

Fig. 3 Estimated coefficients on age groups, in terms of effect on growth rate of GDP per capita. *Vertical bars* demarcate the 15–24 age group. Lagged values of age groups' growth rates are used, to control for possible endogeneity of demographic variables

with the hypothesis stated in earlier sections: that growth in the share of young adults in the household formation stage, between ages 15 and 24, will tend to have a very strong positive effect on growth in consumption, as they set up and furnish their own homes, buy cars, and start families.

The effects of older age groups on the growth rate of per capita GDP are noteworthy. While the oldest age groups exert a negative influence for the Asian Tigers, the Tequila Group, and the USA and Japan, that effect is reversed for "all countries" taken together, in which less developed countries predominate. Perhaps this difference would be due to the presence or absence of government-sponsored programs for support in old age.

However, because other studies to date using the Fair–Dominguez method have restricted their models to the quadratic form, some may think that the more complex effects shown in Fig. 3 are simply the result of over-fitting the data. In order to guard against this, the regressions have been estimated in Table 2 for all countries using a selection of age groups, to test for consistency. Because of multicollinearity it is not possible to include all 17 5-year age groups in the regressions, but 10-year age groups whose effects in Fig. 3 appear to trace out the general shape of the curves for "all countries" have been included: 15–24, 35–44, 45–54, 55–64, and 75–84. The result of this regression is presented in the first column of results in Table 2, where it can be seen that there is

Table 2 GLS fixed-effect regressions of three macroeconomic variables on lagged rates of growth in individual countries' population age shares

Lagged growth rate in shares aged	Growth rate in GDP per capita		Current account balance as % of GDP	Gross capital formation as % of GDP
0–4	NA	NA	NA	NA
5–14		−0.27 (−3.39)	17.0 (1.08)	−27.8 (−2.14)
15–24	0.17 (2.28)	0.17 (2.13)	−23.3 (−1.41)	−57.2 (−4.37)
25–34		0.05 (0.93)	−28.9 (−2.71)	−49.7 (−5.63)
35–44	−0.20 (−4.31)	−0.13 (−2.42)	−0.3 (−0.03)	−6.8 (−0.72)
45–54	0.13 (2.53)	0.19 (3.54)	−2.4 (−0.23)	8.9 (0.99)
55–64	−0.16 (−2.98)	−0.05 (−0.81)	24.6 (2.05)	74.5 (7.35)
65–74		−0.17 (−2.94)	1.7 (0.15)	40.5 (4.28)
75–84	0.28 (6.35)	0.28 (6.20)	18.8 (2.36)	−2.2 (−0.31)
Year dummies?	Yes	Yes	Yes	Yes
Constant	0.06 (5.28)	0.03 (5.08)	−1.9 (−0.39)	17.4 (9.58)
# of obs.	5,671	5,671	3,677	4,800
# of countries	155	155	148	150
R^2				
Within	0.0757	0.0800	0.0361	0.0523
Between	0.1157	0.1553	0.0700	0.0042
Overall	0.0767	0.0877	0.0439	0.0201

t-statistics in parentheses

[a]Lagged values are used to control for possible endogeneity in the demographic variables. Age shares are lagged by using the pattern for the age group five years younger, five years earlier

a direct correspondence between the results of the two approaches, in terms of the sign of the effects. No doubt without the corroboration of the Fair–Dominguez method, one might assume that the many changes in sign in the first column of Table 2 were due to simple multicollinearity, rather than representative of true age group effects on per capita GDP growth.

In fact, the use of a complete set of lagged 10-year age groups produces the same pattern of effect as that shown in Fig. 3, as illustrated in the second column of results in Table 2: a positive and significant effect of the 15–24, 45–54, and 75–84 age groups, with a significant negative effect of the 35–44 and 64–74 age groups.[6]

The 15–24 age group, which has such a consistently positive effect on per capita GDP growth, has consistently negative effects on a country's CAB and

[6]Some comparison can be made here with findings in Feyrer (2007, 2008), who imputes a significant positive effect on output of first differences in the share of the work force aged 40–49, with a negative coefficient on the share aged 20–29. There are a few differences in approach here, in that this study uses rates of change, rather than first difference, in population shares and uses slightly different age groupings (45–54 and 15–24). In addition, Feyrer looks only at the workforce aged 10–69, rather than the full population and age groups, as in this paper. However, the results in Table 3 and in Fig. 3 also show a significant positive effect of the 45–54 group. Direct comparisons for the 15–24 group cannot be made, however, since Feyrer's negative coefficient on the 20–29 age group simply indicated that the coefficient on the 20–29 age group was less than that on the 40–49 group. This is supported by the finding in column 2 of Table 2, although the difference is slight.

GCF. This is shown in the third and fourth columns of results in Table 2, where the effect of the 15–24 age group is negative at about the 0.15 level of significance for the CAB, while the effect is negative and significant at higher than a 0.001 level for GCF. Their strong positive effect on consumption would tend to increase imports, thus reducing the CAB, and drain funds away from capital formation in favor of current consumption, thus reducing GCF.

In addition to the effect of changes in a country's own age distribution, there could be strong effects of changes that occur in that country's trading partners' age distributions. For example, if growth of the share of 15–24-year-olds in the USA increases the USA's tendency to import goods, then that would have a direct effect on US trading partners, where exports would increase. Thus, one would expect an improvement in the current account balance of less developed countries with whom the USA trades. Similarly, if gross capital formation in the USA is negatively affected by increases in the proportion there aged 15–24, then FDI from the USA to other countries might also be reduced.

However, if, after a period of strong increases, the share of the US population aged 15–24 were to decline, the US economy would slow and US trading partners would feel negative repercussions:

> Crashes are more likely if growth in industrial countries has been sluggish. A possible channel is through lower demand for developing country exports, a decline in foreign exchange reserves, and a more likely collapse of the currency. (Milesi-Ferretti and Razin 2000:308)

That hypothesis, of effects on trading partners, has been tested by regressing the CAB, GCF, and GDPpc—in the Asian Tigers and the Tequila group, and in OECD and non-OECD countries—on changes in the proportion aged 15–24 in the USA. The results of those regressions are presented in Table 3, where it can be seen that there are indeed significant effects. They in general support the hypothesis outlined above. The effect on GDPpc in all groups except the Asian Tigers is positive and highly significant. The effect on CAB is positive for all groups and significant in all cases except for the Tequila Group. The effect on GCF is more mixed, with highly significant effects in all groups, but negative only in "all countries," the Asian Tigers, and non-OECD countries.

Another way of looking at the strength of the effect of the 15–24 age group can be seen in Table 4, where the three macroeconomic variables—GDPpc, CAB, and GCF—have been regressed just on a set of year dummies, in order to ascertain the overall time pattern of each variable at the global level over the 45-year period. The coefficients of these regressions have then been regressed on the world's lagged population age share growth rates, using the age groups indicated by the pattern for "all countries" in Fig. 3. The results are not impressive for CAB and GCF, suggesting that the population variables do not have a very significant effect overall. This is understandable when one considers the differential effect of own versus trading partner age patterns. In addition, the actual explanatory power of the original regression used to

Table 3 GLS fixed-effects estimates of effect on other countries, of growth rate in USA share aged 15–24

	All countries	Asian Tigers	Tequila group	OECD countries	Non-OECD countries
Current account balance					
# of obs	3,919	143	154	888	3,031
# of groups	170	5	5	29	141
R^2					
Within	0.0033	0.2103	0.0048	0.0086	0.0034
Between	0.0206	0.0254	0.0732	0.0773	0.0154
Overall	0.0050	0.2040	0.0064	0.0068	0.0043
Est. coeff. on Δ in US share 15–24	37.7	200.8	16.3	21.7	43.4
t Statistic	(3.54)	(6.04)	(0.84)	(2.72)	(3.12)
Gross capital formation					
# of obs	5,042	228	229	1,031	4,011
# of groups	171	5	5	28	143
R^2					
Within	0.0007	0.3528	0.1058	0.0303	0.0035
Between	0.0274	0.0924	0.0493	0.0178	0.0339
Overall	0.0016	0.2990	0.0934	0.0211	0.0047
Est. coeff. on Δ in US share 15–24	−12.6	−254.5	66.9	56.1	−29.3
t Statistic	(−1.89)	(−11.00)	(5.14)	(5.60)	(−3.69)
Growth in per capita GDP					
# of obs	5,995	228	224	1,221	4,774
# of groups	179	5	5	29	150
R^2					
Within	0.0262	0.0155	0.0548	0.0692	0.0246
Between	0.0581	0.0244	0.3116	0.0603	0.0583
Overall	0.0206	0.0133	0.0538	0.0658	0.0182
Est. coeff. on Δ in US share 15–24	0.58	−0.24	0.54	0.43	0.62
t Statistic	(12.52)	(−1.86)	(3.55)	(9.41)	(10.80)

obtain the coefficients was quite low, explaining less than 0.02 of variation overall. But the effect is much more significant for GDPpc (with an overall R^2 in the original regression of 0.0466), where the effect of the 15–24 age group is overwhelmingly positive both in terms of a country's own population as well as in terms of the population of trading partners. There, we see a surprisingly high proportion of the global time pattern of change in GDPpc being explained by demographic variables. The R-square for the full regression in the second column is a high 0.3237, with the 15–24 age group carrying most of the explanatory power. The R-square for the 15–24 age group on its own is 0.2322.

Table 5 presents regressions specifically testing the "match" between single year peaks of the lagged 15–24 share on the one hand, and points of initial decline in the growth rate of GDP per capita on the other. That is, instead of examining the relationship between overall secular trends of the two variables, these regressions look specifically at their tuning points to test the central

Table 4 Regressions of year dummy coefficients on lagged growth rate of world population age shares

Growth rate of share aged	Growth rate of GDP per capita		Current account balance as % of GDP		Gross capital formation as % of GDP	
15–24	0.96 (3.74)	1.18 (2.91)	−37.0 (−1.32)	10.9 (0.23)	41.1 (1.43)	−60.0 (−1.84)
35–44		0.13 (0.44)		58.9 (1.81)		−137.5 (−5.61)
45–54		0.28 (1.01)		31.6 (0.91)		−2.0 (−0.09)
55–64		−0.69 (−1.35)		−57.0 (−1.00)		−41.2 (−0.97)
75–84		0.11 (0.23)		22.0 (0.40)		66.0 (1.68)
Constant	−0.002 (−1.25)	−0.004 (−1.34)	0.18 (0.84)	−0.33 (−0.90)	2.10 (9.64)	2.3 (8.57)
# of obs.	44	44	39	39	45	45
R^2	0.2322	0.3237	0.0190	0.0623	0.0234	0.5222
R^2 in original regression on year dummies						
Within		0.0572		0.0282		0.0328
Between		0.0139		0.0017		0.0004
Overall		0.0466		0.0189		0.0153

The year dummies' coefficients were obtained by regressing each of the three macroeconomic variables only on year dummies. Those year dummy coefficients were then regressed on the rate of growth in the world population age shares. *t* Statistics in parentheses

Table 5 GLS fixed-effect regressions to test whether initial declines in the lagged growth rate in share 15–24 match initial downturns in growth rate of GDP per capita

	All countries	Asian Tigers	Tequila group	OECD	Non-OECD countries	USA[a]
Using each country's own lagged growth rate in share aged 15–24						
Initial decline or turn to negative in lagged growth rate of 15–24?	0.0188 (1.31)[b]	0.191 (1.91)[d]	0.159 (1.48)[b]	0.067 (1.67)[c]	0.010 (0.62)	1.34 (2.45)[d]
Constant	0.19 (44.19)	0.25 (8.11)	0.26 (8.68)	0.25 (19.78)	0.18 (39.61)	−0.77 (−3.54)
R^2						0.1107
Within	0.0002	0.0153	0.0092	0.0020	0.0001	
Between	0.0112	0.0336	0.0021	0.0259	0.0070	
Overall	0.0001	0.0154	0.0092	0.0022	0.0000	
Using USA's lagged growth rate in share aged 15–24						
Initial decline or turn to negative in lagged USA growth rate of 15–24?	0.054 (4.73)[e]	0.137 (1.72)[c]	−0.021 (−0.25)	0.161 (4.98)[e]	0.026 (2.83)[e]	1.34 (2.45)[d]
Constant	0.18 (41.47)	0.23 (7.66)	0.28 (8.82)	0.22 (17.76)	0.18 (37.51)	−0.77 (−3.54)
R^2						0.1107
Within	0.0026	0.0124	0.0003	0.0179	0.0011	
Between	0.0002			0.0000	0.0003	
Overall	0.0024	0.0124	0.0003	0.0175	0.0010	

t Statistics in parentheses

[a] Dependent variable is a dummy set to one for a year in which the GDPpc growth rate drops after increasing in previous period

[b] Significant at the .25 level

[c] Significant at the .10 level

[d] Significant at the .05 level

[e] Significant at the .005 level

hypothesis of this study. Once again, only lagged values of the age group growth rate are used. Six groups are examined:

All countries taken together
The Asian Tigers
The "Tequila Group"
OECD countries
Non-OECD countries
The USA on its own

A dummy variable set to one at the point when the growth rate of GDP per capita declines after a period of increase, is the dependent variable. A dummy variable set to one at the point when the lagged growth rate in the share aged 15–24 declines after a period of increase, or when it turns negative, is the independent variable. The first set of results uses countries' own age structure pattern to set the independent variable, while the second set uses that of the USA, for all countries.

This is a very stringent test, since there are very few points for matching, and they must match exactly, but we do see significant results in both sets of regressions. In the case where countries' own 15–24 pattern is used, the USA and Asian Tigers shows a positive and highly significant result, and the Tequila Group, all countries, and OECD coefficients are positive and marginally significant. Non-OECD countries show no statistical significance.[7]

The second set of results in Table 5, using a dummy for the USA's 15–24 pattern as the independent variable in all cases, shows a strong dependence of other countries on changes in the U.S. share aged 15–24. All except the Tequila Group show a significant result. The Asian Tigers are significant only at the 0.10 level, but for the OECD, all countries taken together, non-OECD countries and of course the USA, the result is positive and highly significant.[8]

Table 6 presents the number and percentage of times, for each group of countries, in which there is a coincidence between an initial decline in the growth rates of both GDP per capita and the (lagged) share aged 15–24. The upper half of the table considers coincidences with the USA pattern of changes in the 15–24 group, while the bottom half looks at coincidences using the countries' own pattern of changes in the 15–24 group. This table shows that in nearly all cases, more than 70% of the times when the growth rate of the share aged 15–24, declined, the growth rate of GDP per capita also declined, in the same or adjacent period. For the USA, this occurred 100% of the time.

[7]For comparison, no other age group showed any significant effect on GDP, except the US and OECD.

[8]Again, for comparison, in this case, no other age group showed any significant effect, for any country group.

Table 6 Number and percent of times when decline in growth rate of GDP per capita coincided with (lagged) decline in growth rate of 15–24 age group share

Group	Total number of declines in GDP per capita	Total number of declines in growth rate of 15–24 group[a]	Number of matches + 1[b]	Number of matches ± 1[c]	Percent of matches ± 1[d]
Based on decline in USA 15–24					
All countries	1,688	899	596	726	80.8
OECD	337	189	138	159	84.1
Non-OECD	1,351	710	458	567	79.9
Asian Tigers	61	35	27	29	82.9
Tequila group	66	35	22	28	80.0
USA	14	7	6	7	100.0
Japan	10	7	4	5	71.4
Mexico	13	7	4	6	85.7
Canada	11	6	5	6	100.0
Great Britain	12	7	4	5	71.4
Germany	10	5	5	5	100.0
Based on decline in countries' own 15–24					
All countries	1,688	557	321	436	78.3
OECD	337	124	77	94	75.8
Non-OECD	1,351	433	244	342	79.0
Asian Tigers	61	21	13	18	85.7
Tequila Group	66	19	10	17	89.5
Japan	10	5	2	2	40.0
Mexico	13	3	2	3	100.0
Canada	11	3	1	2	66.7
Great Britain	12	6	3	5	83.3
Germany	10	3	2	2	66.7

[a]Number of declines in 15–24 in periods when own GDP per capita was reported
[b]Number of times when GDP decline occurred in same year as 15–24 decline, or in following year
[c]Number of times when GDP decline occurred in same year as 15–24 decline, or in a year just before or after
[d]This is the percent of total declines in the growth rate of the 15–24 group that coincided with a decline in the growth rate of GDP per capita

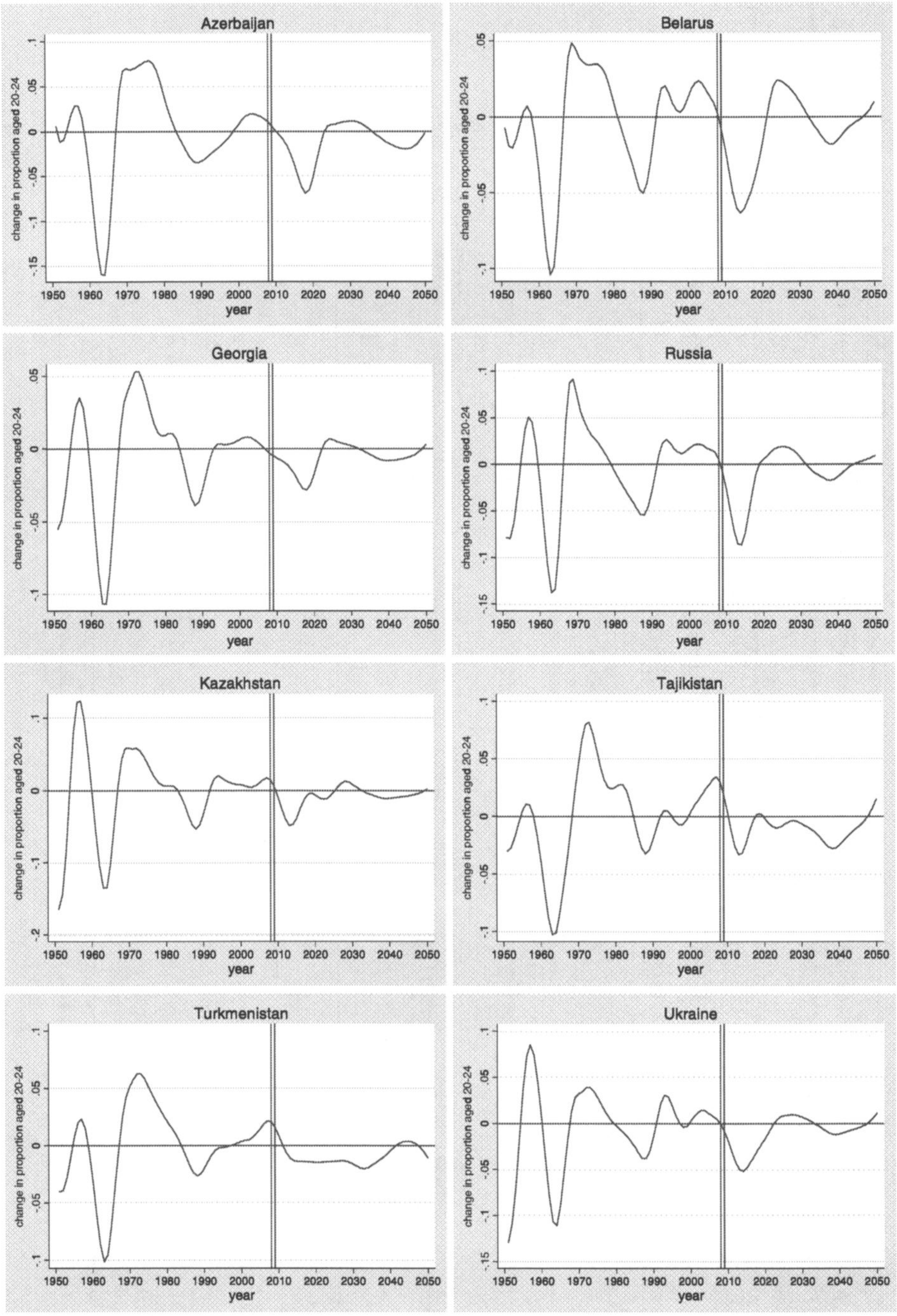

Fig. 4 Eight former Soviet Republics, showing lagged changes in the share aged 20–24 for the 2008–2009 period, with demographic turning points and movement into negative growth

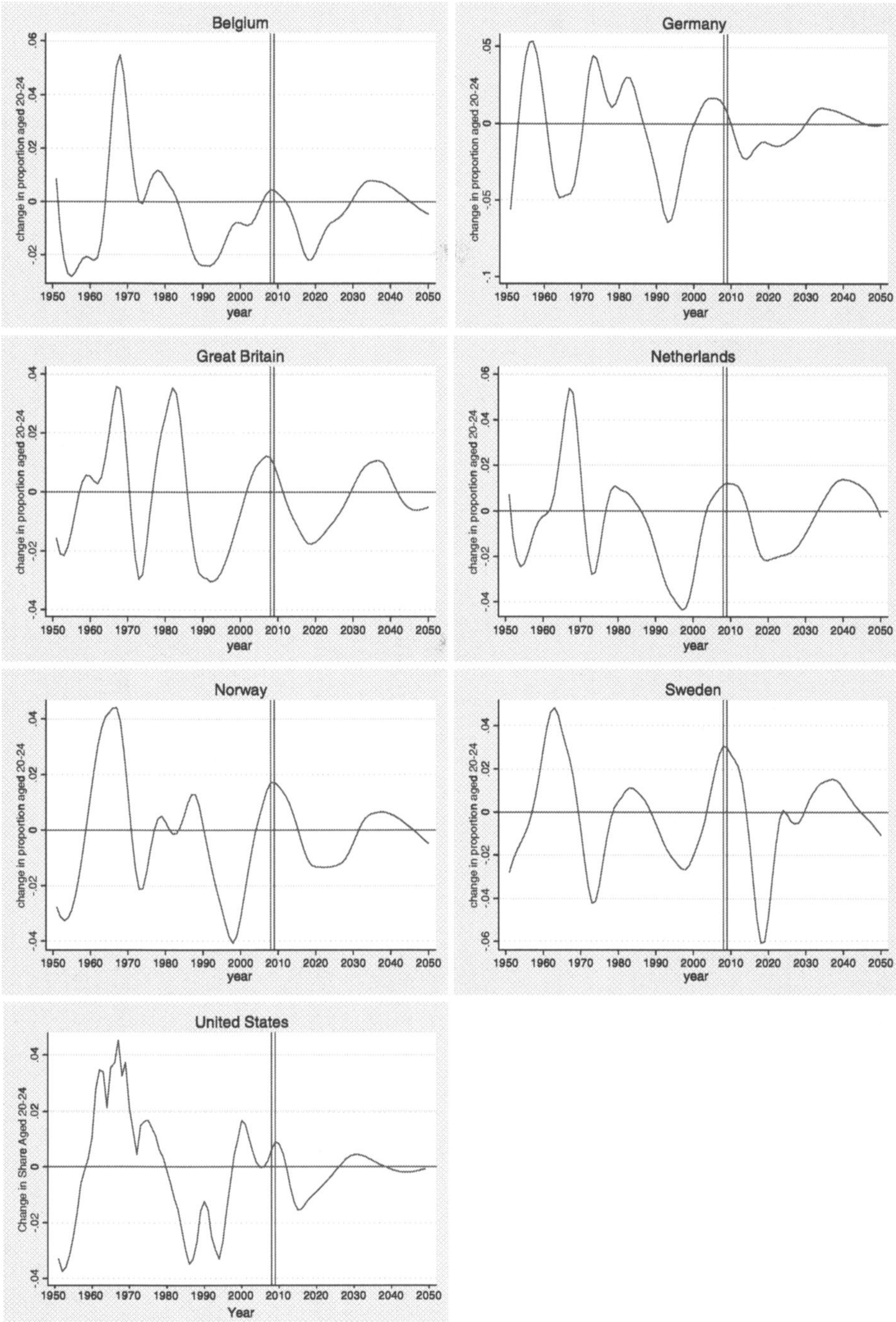

Fig. 5 For the 2008–2009 crisis, showing lagged change in proportion aged 20–24 in seven industrialized countries, with demographic turning points or movement into negative growth

5 Patterns of change in age shares

Figures 4, 5 and 6 examine graphically the approach used in Tables 5 and 6, using the 2008–2009 period as an example. That is, they look at the actual time pattern of (lagged) growth rates in the 15–24 share, to show examples of instances where the economic downturn corresponded with turning points in the demographic variable. 15–24 is a very broad age group, and it is likely that the effects studied here will occur at various points within that age group,

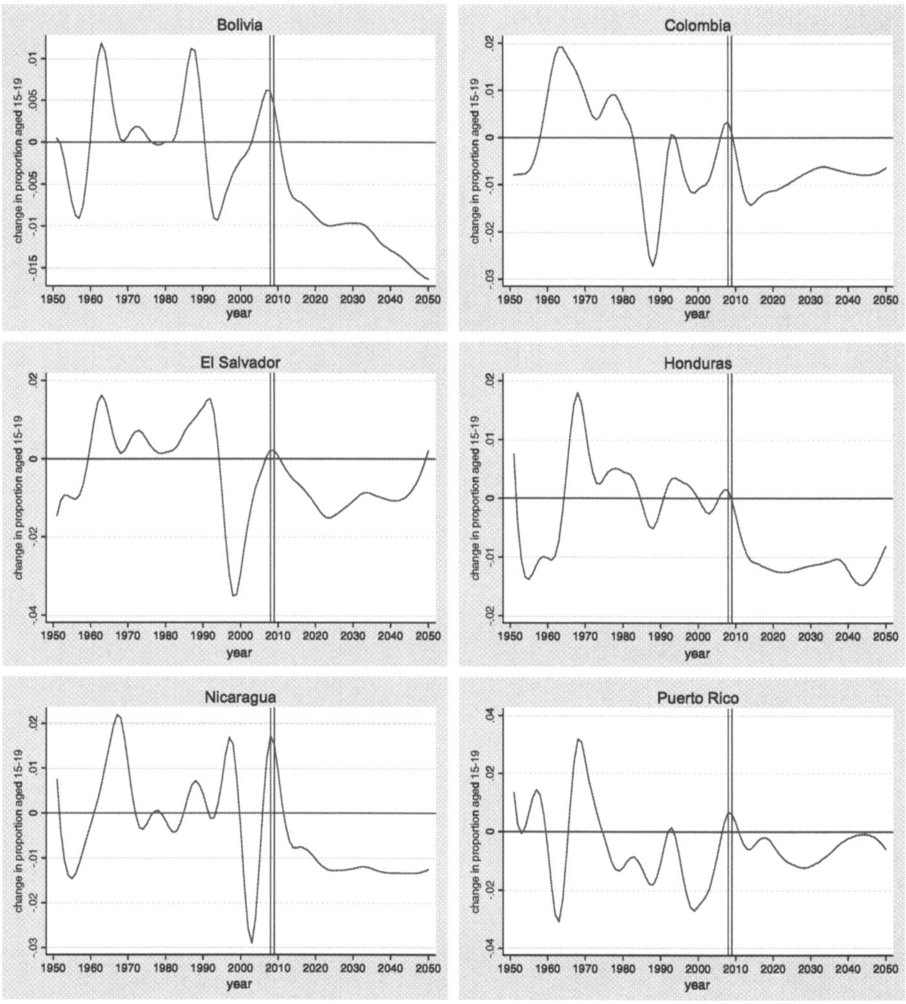

Fig. 6 For the 2008–2009 crisis, showing lagged change in proportion aged 15–19 in six Latin American economies, with demographic turning points or movement into negative growth

depending on the level of educational attainment in a country. For this reason, the graphs in Figs. 4, 5, and 6 make use of two subsets of the 15–24 age group: 15–19 in the Latin American countries, and 20–24 in the more industrialized nations. In country after country, one sees a dip into declining 15–24 growth rates during the 2008–2009 period or even movements into negative growth rates. Similar graphs, not shown here, are presented for the crisis periods of 1980–82, 1992–94 in many Latin American countries, and 1996–98 in the Asian Tigers, in Macunovich (2009).

Figure 4 presents eight former Soviet Republics—Russia, Belarus, Georgia, Ukraine, Azerbaijan, Kazakhstan, Tajikistan, and Turkmenistan; Fig. 5 presents seven industrialized nations—Belgium, Germany, Great Britain, Netherlands, Norway, Sweden, and the USA; and Fig. 6 presents six Latin American countries—Bolivia, Colombia, El Salvador, Honduras, Nicaragua, and Puerto Rico. The OECD countries, which had averaged in the decade before the 2008–2009 crisis, only 1.8 declines per year in the growth rate of the 15–24 group, experienced seven in 2008 and nine in 2009. Table 7 presents a list of some of the countries in which demographic downturns corresponded with severe economic downturns.

Table 7 A selection of countries that experienced downturns in the periods indicated, in growth rates of age groups indicated

	1980–1982	1992–1994	1996–1998	2008–2009
15–19	Brazil[a] Chile[a] Colombia[a] Peru[a] Venezuela[a]	Argentina Brazil Colombia Ecuador[a] Peru Uruguay[a] Venezuela	Hong Kong India Malaysia Philippines[a]	Bolivia[a] Colombia El Salvador Honduras[a] Nicaragua Puerto Rico
20–24	Austria Canada[a] Germany Great Britain Italy[a] Netherlands Russia[a] Spain USA[a]		Japan[a]	Belgium Germany[a] Great Britain Netherlands Norway Sweden USA Belarus[a] Georgia[a] Russia[a] Kazakhstan Tajikistan Turkmenistan Uzbekhistan Ukraine[a]

[a] Age group whose growth rate not only declined—it actually turned negative in or very near the period indicated

6 Conclusions

At least two things appear clear from the previous analyses. One is that there are significant effects of changing demographics on economic indicators: growth in GDPpc especially, as many have suggested earlier, and the current account balance and gross capital formation. The 15–24 age group appears to be key in these effects, with increases in that age group exerting strong positive effects on GDPpc growth, and negative effects on the CAB and GCF. The second is that there have been major shifts in demographic age structure—especially the share of the population aged 15–24—during the past half century or more, many of which correspond closely to periods of economic turmoil. The hypothesis presented in this paper, which appears to be supported by the data, is that increases in the share of the 15–24 age group lead producers to ratchet up their production expectations and take out loans to expand production capacity; but then reductions in that share—or even declining rates of increase—confound these expectations and precipitate a downward spiral of missed loan payments and even defaults and bankruptcies, putting pressure on central banks and causing foreign investors to withdraw funds and speculators to unload the local currency.

This appears to have been the pattern not only during the 1996–98 crisis with the Asian Tigers, but also during the "Tequila" crisis of the early 1990s, the crises that occurred in the early 1980s, among developed as well as developing nations, and the economic downturn experienced by Japan after about 1990. The effect is even more pronounced for the current 2008–2009 period. These results suggest that a good deal more study of demographic effects is warranted.

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