

The Impact of the Durbin Amendment on Merchants: A Survey Study

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The interchange fees associated with debit and credit cards have long been a controversial issue in the retail payments system. These fees are paid by a merchant to the cardholder's bank (the so-called issuer) through the merchant-acquiring bank (the so-called acquirer) when credit or debit card payments are processed. Merchants have criticized that card networks (such as Visa and MasterCard) and their issuing banks have wielded market power to set excessively high interchange fees, which drive up merchants' costs of accepting card payments. The controversy has also attracted great attention from policymakers, who are concerned that high interchange fees may inflate retail prices and cause welfare losses to merchants and consumers.¹

To resolve this issue, a provision of the Dodd-Frank Act, known as the Durbin Amendment, mandates a regulation aimed at reducing debit card interchange fees and increasing competition in the payment processing industry. The Durbin Amendment directs the Federal Reserve Board to regulate debit card interchange fees so that they are "reasonable and proportional to the cost incurred by the issuer with

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¹In recent years, a sizable body of research literature has developed to evaluate whether fee setting in the payment card industry involves some market failure (see, for instance, Rochet and Tirole [2002, 2011], Wright [2003, 2012], Wang [2010], and Bedre-Defolie and Calvano [2013]). Wang (2012) provides a review of the interchange controversy in the U.S. market.

respect to the transaction.” The latter subsequently issued Regulation II (Debit Card Interchange Fees and Routing), which took effect on October 1, 2011.

The regulation establishes a cap on the debit interchange fees that financial institutions with more than \$10 billion in assets can charge to merchants through merchant acquirers. The permissible fees were set based on an evaluation of issuers’ costs associated with debit card processing, clearance, and settlement. The resulting interchange cap is composed of the following: a base fee of 21 cents per transaction to cover the issuer’s processing costs, a 0.05 percent charge of the transaction value to cover potential fraud losses, and an additional 1 cent per transaction to cover fraud prevention costs if the issuer is eligible. This cap applies to both signature and PIN debit cards.

Since its implementation, the regulation has substantially reduced the interchange revenues to covered issuers, while exempt small issuers have been well protected. The cap reduced the average debit interchange fee by almost half from its pre-regulation level.² As a result, covered issuers are losing billions of dollars every year in interchange revenues (Wang 2012; Kay, Manuszak, and Vojtech 2014). However, due to lack of data, the regulation’s impact on merchants has not been much examined, which motivated this study.

In this article, we report results from a merchant survey conducted by the Federal Reserve Bank of Richmond and Javelin Strategy & Research. The survey was performed two years after the regulation was established. The results suggest that the regulation has had limited and unequal impact on merchants’ debit acceptance costs. In the sample of 420 merchants across 26 sectors, two-thirds reported no change or did not know the change of debit costs post-regulation. One-fourth of the merchants, however, reported an increase of debit costs, especially for small-ticket transactions. Finally, less than 10 percent of merchants reported a decrease of debit costs. The impact varies substantially across different merchant sectors.

The survey results also show asymmetric merchant reactions to changing debit costs in terms of adjusting prices and debit restrictions. A sizable fraction of merchants are found to raise prices or debit restrictions as their costs of accepting debit cards increase. However, few merchants are found to reduce prices or debit restrictions as debit costs decrease. The sources of the asymmetric reactions remain a puzzle, which may warrant additional research.

² For an average debit card transaction at \$40, the regulated interchange fee is capped at 24 cents (21 cents + $(\$40 \times 0.05\%)$ + 1 cent).

The article is organized as follows. Section 1 provides industry and regulatory background, which motivates the study. Section 2 introduces the merchant survey and provides an overview of the data. Section 3 uses the survey results to analyze the impact of the regulation on merchants across different sectors in terms of debit costs, price change, and debit restrictions. Section 4 investigates merchants' asymmetric reactions to debit cost changes. Section 5 concludes.

1. MOTIVATION

To understand the debit interchange fee regulation, some familiarity with the market is helpful. Debit cards are one of the most popular general-purpose payment cards in the United States. In 2012, they were used in 47 billion transactions for a total value of \$1.8 trillion.³ Debit card payments are authorized either by the cardholder's signature or by a PIN (personal identification number). The former is called signature debit and the transactions are processed through either the Visa or MasterCard network. The latter is called PIN debit and the transactions are processed through a dozen PIN debit networks.

Visa, MasterCard, and PIN debit networks are commonly referred to as four-party schemes because four parties are involved in each transaction in addition to the network whose brand appears on the card. These parties include: (1) the cardholder who makes the purchase; (2) the merchant who makes the sale and accepts the card payment; (3) the financial institution that issues the card and makes the payment on behalf of the cardholder (the so-called issuer); and (4) the financial institution that collects the payment on behalf of the merchant (the so-called acquirer).

In each of the debit card systems, interchange fees are collectively set by the network on behalf of their member issuers. When accepting a debit card payment, a merchant needs to pay a fee, known as the merchant discount, to the acquirer. The acquirer then passes along a fraction of that to the issuer as the interchange fee.

By regulating the interchange fee, the goal of the Durbin Amendment was to lower merchants' costs of accepting debit cards and to pass along the cost savings to consumers in terms of reduced retail prices. A few years after the regulation was in place, however, it is unclear how effectively the regulation has fulfilled its intention.

There are several important factors that may complicate the intended effects on merchants. First, the regulation sets a cap on the

³ Source: *The 2013 Federal Reserve Payments Study*.

interchange fee but not on the merchant discount rate. The latter is the ultimate fee that a merchant has to pay to the acquirer for accepting a card payment, which typically includes the interchange fee plus the markup charged by the acquirer. Therefore, how much interchange reduction caused by the regulation can be passed along to merchants may depend on the pass-through rate of the acquirers.

Second, small issuers with less than \$10 billion in assets are exempt from the regulation. According to the Federal Reserve Board Survey, exempt transactions constituted 36.5 percent of transaction value and 37.3 percent of transaction volume across all networks in 2013, although the proportions varied by network. For merchants whose customers primarily use exempt debit cards, they may not necessarily see a fall of debit acceptance costs.

Third, the impact can vary substantially by merchant sector. Before the regulation, card networks charged different interchange fees to different merchant sectors, and the fees varied in both level and structure. For example, Visa debit cards charged \$0.20+0.95% (with a \$0.35 cap) to supermarkets, \$0.17+0.75% (with a \$0.95 cap) to gas stations, \$0.20 +0.95% to retail stores, \$0.10+ 1.19% to restaurants, and \$0.75 to utility firms.⁴ Therefore, how much a merchant can benefit from the regulatory cap of \$0.21+0.05% also depends on the sector-specific interchange fees that the merchant used to pay prior to the regulation.

Fourth, interchange fees unintendedly rose for small-ticket transactions (Wang 2014). Prior to the regulation, most networks offered discounted debit interchange fees for small-ticket transactions as a way to encourage card acceptance by merchants for those transactions. For example, Visa and MasterCard used to set the small-ticket debit interchange rate at \$0.04 plus 1.55 percent of the transaction value for sales of \$15 and below. As a result, a debit card would only charge a 7 cent interchange fee for a \$2 sale or 11 cents for a \$5 sale. However, in reaction to the regulation, card networks eliminated the small-ticket discounts and all transactions (except those on cards issued by exempt issuers) have to pay the maximum cap amount, \$0.21+0.05%, set by the regulation. Since merchants may have different compositions of transaction sizes, they could be affected differently by the changes of interchange fees. However, merchants who specialize in small-ticket transactions would be most adversely affected.

Finally, it is unclear how merchants would react to the regulation in terms of changing prices and debit card restrictions. For merchants who had a fall of debit costs, would they reduce prices and encourage the use

⁴ Source: *Visa U.S.A. Interchange Reimbursement Fees, October 2010.*

of debit cards? Alternatively, would merchants who had a rise of debit costs do the opposite? To understand how much the regulation may have indirectly affected consumers, we need to look at these important issues.

In this article, we explore these issues using a merchant survey conducted two years after the regulation. Particularly, we investigate two sets of questions. First, we study how the regulation affected merchants' costs of accepting debit cards and how the cost impact varied across different merchant sectors for all transactions and for small-ticket transactions. Second, we study merchants' reactions to their debit cost changes through changing prices and through encouraging or restricting debit use. In terms of debit restrictions, we consider several practices including minimum amount requirement, surcharge, and discount to nondebit payment means.

2. MERCHANT SURVEY

The Federal Reserve Bank of Richmond contracted with Javelin Strategy & Research, a division of the Greenwich Group, to create and launch an online and telephone survey, which was conducted in winter 2013 through January 2014 to explore the merchant perspective of the Durbin Amendment's impact.

Survey respondents were merchants serving on a pre-existing research panel who sell goods and services directly to consumers and accept debit cards as a payment method.⁵ The sample comprises 420 merchants across 26 sectors in all U.S. states with various attributes.

The survey also collects information regarding the regulation's various impacts on merchants: first, the costs of accepting debit cards for all transactions and for small-ticket transactions; second, the retail prices of goods or services; and third, the restrictions on debit card use, including minimum amount, surcharge, and discount to nondebit payment means.

Below we list a few sample survey questions. For simplicity, the survey uses the Durbin Amendment to refer to the original legislation and the resulting regulation.

- As you know, the Durbin Amendment was the recent policy change in 2011 which states that debit interchange fees be capped at 21 cents per transaction. How have your debit card acceptance costs changed after the Durbin Amendment came into effect?

⁵ One limitation of the survey is that it does not include merchants who did not accept debit cards at the time of the survey, so it does not provide information on how the regulation may have affected debit card acceptance.

(a) Costs increased; (b) No change in cost; (c) Costs decreased; (d) I do not know.

- After the Durbin Amendment in 2011, have you experienced an impact on the costs to accept debit card transactions with values of \$10 and less? (a) Yes, the cost increased; (b) No, there has been no impact; (c) Yes, the cost decreased; (d) I do not know.
- Has the Durbin Amendment directly impacted the price of the goods or services you sell or offer? (a) Yes, prices were increased because of Durbin; (b) No, Durbin had no impact on prices; (c) Yes, prices were decreased because of Durbin.
- Prior to the Durbin Amendment in 2011, did you set a minimum charge to accept debit card payments? (a) Yes; (b) No; (c) Did not accept debit cards prior to 2011.

Do you currently have a minimum charge to accept debit card payments? (a) Yes; (b) No.

Similarly, the survey also asked questions on surcharges and discounts on debit cards and other payment means, including cash, check, and credit cards, before and after the regulation.

To analyze the survey responses, we divide the data into two categories. The first category comprises data on merchants' attributes, which will be used as explanatory variables in our following regression analysis. For each merchant, we have information on its sector, years in business, whether or not it accepts emerging payments (e.g., Square, Google, or PayPal), customer base, sales channels, geographic location, annual sales, and average ticket size.

The second category comprises data related to merchant impact from and reactions to the regulation, including cost changes for debit acceptance, price changes, and changing debit restrictions, which will serve as dependent variables in our regression analysis.

Table 1 provides a summary of the merchant attribute variables. Merchants in the sample belong to 26 sectors, of which fast food, restaurants, and apparel each account for 11 percent–17 percent of the sample, and the other sectors each account for a share below 10 percent. Some of the merchants operate in multiple sectors, so the sum of sector shares shown in Table 1 exceeds 100 percent. Of the merchants who reported, 3.8 percent said they had existed in business less than two years; 24.5 percent accepted emerging payments; and 46.7 percent were primarily serving repeat customers. Also, 86.4 percent of the merchants were selling through physical stores, 40.7 percent through online, and 35.2 percent through other sales channels (e.g., catalog and mail orders). Moreover, merchants in the sample distribute quite evenly across nine

Table 1 Summary of Merchant Attribute Variables (N=420)

Merchant Sectors		Other Attributes	
Apparel	10.5%	New Firm	3.8%
Art	2.4%	Emerging Payments	24.5%
Auto	6.7%	Repeat Customers	46.7%
Casinos	1.7%	Physical Store	86.4%
Consumer Electronics	7.9%	Online Channel	40.7%
Convenience Stores	6.7%	Other Channel	35.2%
Delivery Services	2.9%	East North Central	24.3%
Department Stores	3.1%	East South Central	13.8%
Discount Retail	5.2%	Middle Atlantic	23.8%
Education	0.5%	Mountain	17.4%
Entertainment	8.3%	New England	16.7%
Fast Food	16.7%	Pacific	28.3%
Grocery Stores	6.0%	South Atlantic	28.1%
Home Furnishings	6.0%	West North Central	16.9%
Home Improvement	5.5%	West South Central	21.0%
Hospitality	3.8%	Sales < \$100,000	18.1%
Maintenance	4.0%	Sales \$100,000-\$1M	30.7%
Medical	6.9%	Sales \$1M-\$10M	25.7%
Office Products	2.9%	Sales \$10M-\$100M	16.4%
Other Sector	3.3%	Sales > \$100M	3.8%
Real Estate	1.4%	Sales Missing	5.2%
Restaurants	10.7%	Average Ticket < \$10	23.81%
Services	5.0%	Average Ticket \$10-\$50	22.14%
Sporting Goods	3.8%	Average Ticket \$50-\$250	30.71%
Toys	3.8%	Average Ticket >\$250	23.33%
Transportation	4.5%		

census districts, annual sales ranges (except for the largest sales range above \$100 million), and average ticket sizes.

Table 2 provides a summary of merchant impact/reaction variables. Most respondents (67 percent) reported no change or did not know the change in their overall costs of accepting debit cards post-regulation. Among those who did see a change in debit costs, about three times as many (25 percent over 8 percent) reported a cost increase as those who reported a cost decrease. A similar pattern is found for small-ticket transactions, while nine times as many (27 percent over 3 percent) respondents reported a cost increase as those who reported a cost decrease.

The majority of respondents (75 percent) reported no price change due to the regulation. For those who had a price change, 11 times more (23 percent over 2 percent) reported price hikes than cuts. Meanwhile, most respondents (76 percent) reported no increase or decrease in the restrictions on debit card use. For those who did report a change, they are even on each side (12 percent and 12 percent).

**Table 2 Summary of Merchant Impact/Reaction Variables
(N=420)**

Merchant Average	Decrease	Stay the Same	Increase	Don't Know
Cost Change	8%	41%	25%	26%
Small-Ticket Cost Change	3%	47%	27%	24%
Price Change	2%	75%	23%	0%
Debit Restriction Change	12%	76%	12%	0%
	Minimum Amount	Surcharge	Discount	Others
Before Durbin	26%	24%	20%	55%
After Durbin	29%	20%	20%	58%

Note that the restrictions on debit card use are measured by three practices, namely, whether the merchant imposes a minimum amount requirement on debit transactions, surcharges debit cards, or offers discounts only to nondebit payment means. In the case that a merchant added more (or dropped some) restrictions on accepting debit cards after the regulation, we call it increasing debit restrictions (or decreasing debit restrictions).⁶

Table 2 also provides information on merchants' practices on each specific debit restriction before and after the regulation. In the sample, 26 percent of merchants imposed the minimum amount on debit transactions prior to the regulation, and the fraction changed to 29 percent post-regulation. Meanwhile, the fraction of merchants surcharging debit cards changed from 24 percent to 20 percent, and the fraction of merchants offering discounts only to nondebit payment means remained at 20 percent.

Finally, Table 3 drops multisector merchants and summarizes merchant impact/reaction variables based on 362 merchants that only operate in one sector. For each variable, we report the average fraction across 26 sectors so that the results would not be driven by certain sectors that have more observations. Nevertheless, the patterns are very similar to Table 2.

⁶ Here, a merchant's change in debit restrictions is measured by comparing the numbers of restrictions before and after the regulation. We use this measure for the analysis in Section 3. However, in Section 4, we take a step further to look at each type of the three restrictions.

Table 3 Summary of Merchant Impact/Reaction Variables Based on One-Sector Merchants (N=362)

Sector Average	Decrease	Stay the Same	Increase	Don't Know
Cost Change	9%	43%	25%	23%
Small-Ticket Cost Change	3%	49%	25%	23%
Price Change	2%	76%	23%	0%
Debit Restriction Change	13%	73%	14%	0%

3. REGULATORY IMPACT ON MERCHANTS

In this section, we conduct ordered logit regressions to estimate the debit interchange regulation's impact on merchants on several aspects, including the change of merchants' costs of accepting debit cards for all transactions and for small-ticket transactions, price changes, and the change of debit restrictions. In this analysis, we do not intend to identify any causal effects or impact channels. Rather, our focus is to investigate how the regulation's impact varies across different merchant sectors.

In each of the regressions, we include sector dummies together with other merchant attribute variables listed in Table 1.⁷ The sample we use comprises merchants operating only in one sector, so that the estimated sector dummies clearly identify the sector fixed effect, and we exclude merchants who reported "do not know" regarding their debit cost changes wherever appropriate.

The ordered logit regression assumes the following structure. Suppose the underlying process to be characterized is

$$y^* = x\beta + \varepsilon,$$

where y^* is the exact but unobserved dependent variable, x is a vector of independent variables, and we observe the categories of outcome

$$y = \begin{cases} 0 \text{ (decrease)}, & \text{if } y^* \leq u_1, \\ 1 \text{ (unchanged)}, & \text{if } u_1 < y^* < u_2, \\ 2 \text{ (increase)}, & \text{if } y^* \geq u_2, \end{cases}$$

⁷ Note that we exclude average ticket size as an explanatory variable in all regressions because of its duplication with the sector fixed effect.

Table 4 Debit Cost Change for All Transactions (Estimated Probabilities)

Merchant Sector	Decrease	Stay the Same	Increase
Apparel	0.070	0.632***	0.298
Art	0.357	0.589**	0.054
Auto	0.100*	0.677***	0.224**
Casinos	0.112**	0.686***	0.202**
Consumer Electronics	0.126**	0.693***	0.181**
Convenience Stores	0.242	0.667***	0.091
Delivery Services	0.000	0.000	1.000***
Department Stores	0.032	0.474***	0.495***
Discount Retail	0.059	0.603***	0.338*
Entertainment	0.163*	0.696***	0.141*
Fast Food	0.016*	0.327***	0.657***
Grocery Stores	0.026*	0.433***	0.541***
Home Furnishings	0.259**	0.658***	0.084*
Home Improvement	0.034	0.489**	0.478*
Hospitality	0.106	0.682***	0.211
Maintenance	0.166*	0.696***	0.138
Medical	0.141	0.696***	0.162
Office Products	0.024	0.414*	0.561**
Other Sector	0.038	0.515***	0.447**
Real Estate	0.038	0.513***	0.449**
Restaurants	0.047**	0.561***	0.392***
Services	0.140**	0.696***	0.164***
Sporting Goods	0.259**	0.658***	0.084*
Toys	0.077	0.647***	0.276
Transportation	0.139***	0.696***	0.165***
Sector Average	0.111	0.576	0.313

Notes: ***p<0.01, **p<0.05, *p<0.1. The estimated probabilities are based on an ordered logit regression that includes other regressors as shown in Table 1. (Obs: 254; R²: 0.17).

where u_1 and u_2 are latent thresholds. Then the ordered logit regression will use the observations on y , which are a form of censored data on y^* to estimate the parameter vector β and the thresholds u_1 and u_2 .

Tables 4 and 5 report the model-estimated distributions of debit cost change for all transactions and for small-ticket transactions across 26 merchant sectors, taking all the other merchant attribute variables at their mean values.

The results suggest limited and unequal impact on merchant debit costs: Averaging across 26 sectors, 11.1 percent of merchants are estimated to have reduced debit costs for all transactions, 31.3 percent have increased costs, and 57.6 percent are unchanged. For small-ticket

**Table 5 Debit Cost Change for Small-Ticket Transactions
(Estimated Probabilities)**

Merchant Sector	Decrease	Stay the Same	Increase
Apparel	0.008	0.577***	0.415***
Art	0.081	0.860***	0.060
Auto	0.071*	0.861***	0.068*
Casinos	0.000	0.000	1.000***
Consumer Electronics	0.026	0.802***	0.172
Convenience Stores	0.058	0.859***	0.083
Delivery Services	0.003	0.371	0.626**
Department Stores	0.038**	0.838***	0.125***
Discount Retail	0.006	0.501**	0.493**
Entertainment	0.025	0.796***	0.180**
Fast Food	0.004	0.396***	0.600***
Grocery Stores	0.017	0.743***	0.239*
Home Furnishings	0.167**	0.806***	0.027*
Home Improvement	0.030	0.816***	0.155
Hospitality	0.018	0.745***	0.238*
Maintenance	0.003	0.316	0.681***
Medical	0.018	0.751***	0.231**
Office Products	0.003	0.364	0.633
Other Sector	0.013	0.696***	0.290
Real Estate	0.007	0.545**	0.448
Restaurants	0.022*	0.782***	0.195**
Services	0.035**	0.831***	0.134***
Sporting Goods	0.016	0.732***	0.252
Toys	0.008	0.593***	0.399**
Transportation	0.020	0.764***	0.216
Sector Average	0.028	0.654	0.318

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimated probabilities are based on an ordered logit regression that includes other regressors as shown in Table 1. (Obs: 259; R^2 : 0.20).

transactions, only 2.8 percent are estimated to have reduced debit costs, 31.8 percent have increased costs, and 65.4 percent are unchanged.⁸

As mentioned before, the mixed cost impact on merchants may result from several complication factors discussed in Section 1, which could vary substantially by sector. Merchants who had reduced total debit costs could be those who gained more from the large-ticket transactions than losing on small-ticket ones. Merchants who had no change on total debit costs could be those whose customers were primarily using debit cards from exempt issuers or whose loss from

⁸ Our estimated distributions are fairly consistent with the pattern found in the raw data. However, the regression analysis allows us to control other merchant attributes while identifying the sector effects.

small-ticket transactions balanced out gains from large-ticket ones. Finally, merchants who had increased total debit costs could be those who specialized on small-ticket transactions.

The estimated cost impact varies substantially across merchant sectors:

- Top sectors of total debit cost reduction are home furnishings (25.9 percent), sporting goods (25.9 percent), maintenance (16.6 percent), entertainment (16.3 percent), and services (14.0 percent).
- Top sectors of total debit cost increase are delivery services (100 percent), fast food (65.7 percent), office products (56.1 percent), grocery stores (54.1 percent), and home improvement (47.8 percent).
- Top sectors of small-ticket debit cost increase are casinos (100 percent), maintenance (68.1 percent), delivery services (62.6 percent), fast food (60.0 percent), and discount retail (49.3 percent).

It is intuitive that fast food and delivery services rank top in both total debit cost increase and small-ticket debit cost increase. Presumably, merchants in those sectors deal with mostly small-ticket transactions, so they were likely to feel cost increases in both small-ticket and total debit transactions. However, home furnishings and sporting goods rank top in total debit cost reduction, which may reflect their relatively large transaction sizes.

Table 6 reports the model-estimated probabilities of price change. The results suggest the regulation has had a limited impact on prices. Averaging across all sectors, it is estimated that the majority of merchants (77.2 percent) did not change prices post-regulation, very few merchants (1.2 percent) reduced prices, while a sizable fraction of merchants (21.6 percent) increased prices.

The estimated price change pattern also varies by sector:

- Top sectors of price increase are delivery services (100 percent), office products (77.8 percent), fast food (39.6 percent), and apparel (28.6 percent).
- Top sectors of price decrease are auto (5.6 percent), other sector (4.3 percent), sporting goods (2.7 percent), and art (2.5 percent).

Table 7 reports the model-estimated probabilities of changing debit restrictions. Again, the results suggest limited and unequal impact. Averaging across all sectors, it is estimated that the majority of merchants (76.6 percent) did not change debit restrictions post-regulation,

Table 6 Change of Prices: Estimated Probabilities

Merchant Sector	Decrease	Stay the Same	Increase
Apparel	0.002	0.711***	0.286***
Art	0.025**	0.940***	0.035
Auto	0.056**	0.929***	0.015*
Casinos	0.037	0.940***	0.024
Consumer Electronics	0.006	0.863***	0.131
Convenience Stores	0.002	0.686***	0.312
Delivery Services	0.000	0.000	1.000***
Department Stores	0.002	0.655**	0.343
Discount Retail	0.005	0.827***	0.168
Entertainment	0.009	0.895***	0.097
Fast Food	0.001	0.602***	0.396***
Grocery Stores	0.003	0.734***	0.264*
Home Furnishings	0.015	0.929***	0.056
Home Improvement	0.004	0.822***	0.174
Hospitality	0.006	0.866***	0.127*
Maintenance	0.002	0.661***	0.337*
Medical	0.006	0.852***	0.142*
Office Products	0.000	0.222	0.778***
Other Sector	0.043**	0.937***	0.020*
Real Estate	0.009	0.902***	0.089
Restaurants	0.002	0.727***	0.270***
Services	0.011	0.910***	0.080*
Sporting Goods	0.027**	0.941***	0.032**
Toys	0.032	0.941***	0.027
Transportation	0.004	0.798***	0.199
Sector Average	0.012	0.772	0.216

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimated probabilities are based on an ordered logit regression that includes other regressors as shown in Table 1. (Obs: 340; R^2 : 0.21).

12.4 percent of merchants increased debit restrictions, while 10.9 percent decreased restrictions.

The estimated changing debit restriction pattern varies by sector:

- Top sectors of increased debit restrictions are maintenance (30.8 percent), other sector (25.7 percent), transportation (20.2 percent), and hospitality (18.9 percent).
- Top sectors of reduced debit restrictions are sporting goods (26.5 percent), services (16.9 percent), fast food (11.8 percent), and home improvement (11.8 percent).

It is interesting to see sporting goods ranks top in both price reduction and debit restriction reduction. This is consistent with the finding above that the sector ranks top in the total debit cost reduction. In contrast, fast food ranks top in price increase but also in reducing

Table 7 Change of Debit Restrictions: Estimated Probabilities

Merchant Sector	Decrease	Stay the Same	Increase
Apparel	0.161**	0.792***	0.047**
Art	0.142	0.804***	0.054
Auto	0.112*	0.818***	0.070*
Casinos	0.092*	0.823***	0.0860*
Consumer Electronics	0.073	0.820***	0.107
Convenience Stores	0.099**	0.822***	0.080**
Delivery Services	0.011	0.517*	0.472
Department Stores	0.033	0.750***	0.217
Discount Retail	0.255	0.718***	0.027
Entertainment	0.064*	0.814***	0.122**
Fast Food	0.118**	0.816***	0.066**
Grocery Stores	0.111**	0.818***	0.071*
Home Furnishings	0.042	0.780***	0.178
Home Improvement	0.118**	0.816***	0.066**
Hospitality	0.039	0.772***	0.189*
Maintenance	0.021	0.671***	0.308**
Medical	0.117*	0.816***	0.067*
Office Products	0.041	0.776***	0.183
Other Sector	0.027*	0.717***	0.257**
Real Estate	0.387	0.599**	0.015
Restaurants	0.109***	0.819***	0.072***
Services	0.169*	0.786***	0.045
Sporting Goods	0.265**	0.710***	0.026
Toys	0.092	0.822***	0.085
Transportation	0.036	0.762***	0.202*
Sector Average	0.109	0.766	0.124

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The estimated probabilities are based on an ordered logit regression that includes other regressors as shown in Table 1. (Obs: 340; R^2 : 0.10).

debit restrictions. This may reflect the nature of the business where merchants value particularly the checkout speed so they responded to a rise of debit costs mainly through a price increase instead of adding debit restrictions.

4. MERCHANT REACTIONS TO DEBIT COST CHANGES

In this section, we take a step further to investigate the impact channels behind the intended and unintended consequences of the regulation. We examine two sets of questions. One is on the intended effects: Did lower debit costs lead to lower retail prices and debit restrictions? The

other is on the unintended effects: Did higher debit costs lead to higher retail prices and debit restrictions?

The analysis is conducted using logit regressions, which connect survey respondents' answers of their post-regulation debit cost changes with their reported changes of prices and debit restrictions. The sample we use again comprises merchants operating only in one sector, but we no longer need to exclude merchants who reported "do not know" regarding their debit cost changes.

Reactions to a Debit Cost Decrease

We first analyze merchants' reactions to a debit cost decrease. We run five separate logit regressions, with the binary dependent variables being merchants' status post-regulation. Specifically, in each of the five regressions, the dependent variable takes the value of 1 (otherwise, 0) if a merchant satisfies the respective criteria: (1) price decrease; (2) no debit restriction; (3) no minimum amount requirement on debit transactions; (4) no surcharge on debit cards; and (5) no discount offered only to nondebit payment means.

On the explanatory variable side, we control for merchants' debit restrictions prior to the regulation as well as other attributes listed in Table 1. We also divide merchants into four dummy groups according to their debit cost changes: (1) small-ticket costs decreased, total costs decreased; (2) small-ticket costs decreased, total costs did not decrease; (3) small-ticket costs did not decrease, total costs decreased; (4) small-ticket costs did not decrease, total costs did not decrease. Using these dummy variables will allow us to separate the variation of merchant reactions due to different types of cost shocks.

Table 8 reports the logit regression results. The first column is the price reaction. However, the regression fails to run given that too few merchants reported a price reduction.

The next four columns in Table 8 show the estimated merchant reactions in terms of debit restrictions. First, the results suggest that merchants tend to have persistent policies. If a merchant did not impose any debit restrictions (or specifically, requiring minimum amount on debit transactions, surcharging debit cards, or offering discount only to nondebit payment means) prior to the regulation, it is likely the merchant would not restrict debit post-regulation. The persistence effects are statistically and economically significant. To put the estimation results into perspective, Table 9 reports the estimated probabilities. Holding other explanatory variables at their mean values, if a merchant did not impose any debit restrictions prior to the regulation, there

Table 8 Logit Regressions: Merchant Reactions to a Debit Cost Decrease

Variables	Price Decrease	Not Restricting Debit After	No Minimum After	No Surcharge After	No Discount After
Not Restricting Debit Before	—	0.746*** (0.051)			
No Minimum Before	—		0.611*** (0.072)		
No Surcharge Before	—			0.877*** (0.048)	
No Discount Before	—				0.889*** (0.058)
Small-Ticket Costs Decreased, Total Costs Decreased	—	0.258*** (0.047)		0.018 (0.012)	
Small-Ticket Costs Decreased, Total Costs Did Not Decrease	—		-0.233 (0.409)	0.018 (0.012)	0.015 (0.019)
Small-Ticket Costs Did Not Decrease, Total Costs Decreased	—	-0.004 (0.184)	0.125** (0.058)	-0.027 (0.073)	-0.005 (0.018)
Other Regressors	—	Included	Included	Included	Included
Obs		334	330	285	324
Pseudo R ²	—	0.530	0.383	0.663	0.659

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1.

**Table 9 Merchant Reactions to a Debit Cost Decrease
(Estimated Probabilities)**

Variables	Not Restricting Debit After	No Minimum After	No Surcharge After	No Discount After
Had Restriction/Minimum/Surcharge/Discount Before	0.193*** (0.044)	0.305*** (0.068)	0.120*** (0.047)	0.105* (0.055)
Didn't Have Restriction/Minimum/Surcharge/Discount Before	0.939*** (0.019)	0.916*** (0.022)	0.997*** (0.003)	0.994*** (0.004)
Small-Ticket Costs Decreased, Total Costs Decreased	0.975*** (0.030)		1.000*** (0.000)	
Small-Ticket Costs Decreased, Total Costs Did Not Decrease		0.581 (0.417)	1.000*** (0.000)	0.993*** (0.019)
Small-Ticket Costs Did Not Decrease, Total Costs Decreased	0.713*** (0.183)	0.949*** (0.054)	0.953*** (0.080)	0.973*** (0.022)
Small-Ticket Costs Did Not Decrease, Total Costs Did Not Decrease	0.717*** (0.042)	0.824*** (0.031)	0.982*** (0.013)	0.978*** (0.012)
Other Regressors	At mean	At mean	At mean	At mean
Obs	334	330	285	324

Notes: Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1.

is a 93.9 percent chance that the merchant will not restrict debit use post-regulation. Otherwise, the chance would be reduced to 19.3 percent. A similar pattern is found for each of the specific restrictions, namely minimum amount, surcharge, and discount.

Second, the reduction of debit costs does not seem to have a big impact on reducing debit restrictions. As shown in Table 8, the dummy variable “small-ticket costs did not decrease, total costs decreased” is not statistically significant for most regressions except for that of minimum amount. Table 9 reports the estimated probabilities. Holding other explanatory variables at their mean values, if a merchant did not have a reduction for either the total debit costs or the small-ticket costs, there is a 71.7 percent chance that the merchant would not impose any debit restrictions post-regulation. In comparison, if the merchant belongs to the group that “small-ticket costs did not decrease, total costs decreased,” the chance of not restricting debit use is 71.3 percent post-regulation, almost no difference. The same pattern is found for the regressions on surcharge and discount. However, there is some effect in the minimum amount regression, though the magnitude is relatively small. As shown in Table 9, if a merchant did not have a reduction for either the total debit costs or the small-ticket costs, there is an 82.4 percent chance that the merchant would not impose a minimum amount on debit transactions post-regulation. In contrast, if the merchant belongs to the group that “small-ticket costs did not decrease, total costs decreased,” the chance of not imposing a minimum amount on debit transactions would rise to 94.9 percent post-regulation, a 12.5 percent increase.

Note that most merchants in the sample who had a debit cost decrease belong to the group “small-ticket costs did not decrease, total costs decreased.” As shown in Table 10, among the 362 one-sector merchants in the sample, they account for 7.1 percent. In contrast, only 1.8 percent of merchants belong to the group “small-ticket costs decreased, total costs decreased,” and 0.6 percent belong to the group “small-ticket costs decreased, total costs did not decrease.” Accordingly, the estimated parameters for the latter two group dummies are less meaningful. In fact, they are dropped from some of the regressions due to lack of variation.

Reactions to a Debit Cost Increase

We then analyze merchants’ reactions to a debit cost increase. We also run five separate logit regressions, with each of the dependent variables being a merchant’s status post the regulation: (1) price increase; (2) restricting debit use; (3) imposing minimum amount on debit

Table 10 Variation of Debit Cost Decrease Across Merchant Sectors

Merchant Sector	Small-Ticket Costs Decreased, Total Costs Decreased	Small-Ticket Costs Decreased, Total Costs Did Not Decrease	Small-Ticket Costs Did Not Decrease, Total Costs Decreased	Small-Ticket Costs Did Not Decrease, Total Costs Did Not Decrease
Apparel	0%	0%	17%	83%
Art	13%	0%	13%	75%
Auto	0%	0%	13%	88%
Casinos	0%	0%	0%	100%
Consumer Electronics	0%	0%	8%	92%
Convenience Store	15%	0%	15%	69%
Delivery Services	0%	0%	0%	100%
Department Stores	0%	0%	0%	100%
Discount Retail	8%	0%	0%	92%
Entertainment	0%	0%	10%	90%
Fast Food	0%	0%	2%	98%
Grocery Stores	0%	6%	0%	94%
Home Furnishings	0%	0%	0%	100%
Home Improvement	0%	0%	10%	90%
Hospitality	0%	0%	7%	93%
Maintenance	0%	0%	17%	83%
Medical	0%	0%	16%	84%
Office Products	0%	17%	0%	83%
Other Sector	8%	0%	0%	92%
Real Estate	0%	0%	0%	100%
Restaurants	3%	0%	0%	97%
Services	0%	0%	10%	90%
Sporting Goods	0%	0%	25%	75%
Toys	0%	0%	17%	83%
Transportation	0%	0%	0%	100%
Merchant Average	1.8%	0.6%	7.1%	90.6%
Sector Average	1.9%	0.9%	7.2%	90.1%

transactions; (4) surcharging debit cards; and (5) offering discounts only to nondebit payment means.

On the explanatory variable side, we again control for merchants' debit restrictions prior to the regulation, debit cost changes post-regulation, and other merchant attributes.

Table 11 reports the coefficient estimates. Again, the results show merchants' debit restriction policies are persistent. If a merchant imposed debit restrictions (or specifically, minimum amount, surcharge, or discount) prior to the regulation, it is likely the merchant would continue to do so post-regulation. Table 12 reports the estimated probabilities. Holding other explanatory variables at their mean values, if a merchant imposed any debit restrictions prior to the regulation, there is a 78.2 percent chance the merchant will continue to restrict debit use post-regulation. Otherwise, the chance is only 6.46 percent. A similar pattern is found for each of the three specific restrictions.

More interestingly, the results in Table 11 show that debit cost increases have significant effects on increasing merchants' prices and debit restrictions. Table 12 reports the estimated probabilities. Holding other explanatory variables at their mean values, if a merchant had no change for either the total debit costs or the small-ticket costs, there is only a 5.1 percent chance that the merchant would raise prices. However, if a merchant belongs to the group "small-ticket costs increased, total costs increased," the chance rises to 59.6 percent; for the group "small-ticket costs increased, total costs did not increase," the chance is 74.7 percent; and for the group "small-ticket costs did not increase, total costs increased," the chance is 33.1 percent. In other words, merchants in our sample are likely to pass along their increased debit costs to prices.

Similarly, the results show that merchants in our sample are likely to increase debit restrictions in reaction to debit cost increases. According to Table 12, holding other explanatory variables at their mean values, if a merchant had no change for either total debit costs or small-ticket costs, there is only a 17 percent chance that the merchant would restrict debit use post-regulation. However, if a merchant belongs to the group "small-ticket costs increased, total costs increased," the chance rises to 57.3 percent; for the group "small-ticket costs increased, total costs did not increase," the chance is 41.4 percent; and for the group "small-ticket costs did not increase, total costs increased," the chance is 68.1 percent. Moreover, most of the effects are found working through the minimum amount requirement, and to a less extent, through surcharging.

Table 11 Logit Regressions: Merchant Reactions to a Debit Cost Increase

Variables	Price Increase	Restricting Debit After	Minimum After	Surcharge After	Discount After
Restricting Debit Before		0.718*** (0.055)			
Minimum Before			0.473*** (0.098)		
Surcharge Before				0.724*** (0.099)	
Discount Before					0.830*** (0.074)
Small-Ticket Costs Increased, Total Costs Increased	0.630*** (0.095)	0.428*** (0.111)	0.431*** (0.111)	0.152* (0.086)	0.054 (0.048)
Small-Ticket Costs Increased, Total Costs Did Not Increase	0.761*** (0.079)	0.286 (0.184)	0.315* (0.160)	0.136 (0.099)	0.011 (0.026)
Small-Ticket Costs Did Not Increase, Total Costs Increased	0.431*** (0.154)	0.526*** (0.124)	0.421*** (0.144)	0.091 (0.153)	0.058 (0.062)
Other Regressors	Included	Included	Included	Included	Included
Obs	292	336	336	285	330
Pseudo R ²	0.426	0.568	0.443	0.684	0.653

Notes: Robust standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1.

**Table 12 Merchant Reactions to a Debit Cost Increase
(Estimated Probabilities)**

Variables	Price Increase	Restricting Debit After	Minimum After	Surcharge After	Discount After
Didn't Have Restriction/Minimum/ Surcharge/Discount Before		0.065*** (0.020)	0.079*** (0.020)	0.004 (0.004)	0.007 (0.005)
Had Restriction/Minimum/ Surcharge/Discount Before		0.782*** (0.049)	0.551*** (0.094)	0.728*** (0.099)	0.836*** (0.072)
Small-Ticket Costs Increased, Total Costs Increased	0.596*** (0.103)	0.573*** (0.100)	0.451*** (0.102)	0.119* (0.068)	0.061 (0.043)
Small-Ticket Costs Increased, Total Costs Did Not Increase	0.747*** (0.106)	0.414** (0.171)	0.309** (0.137)	0.086 (0.053)	0.022 (0.023)
Small-Ticket Costs Did Not Increase, Total Costs Increased	0.331** (0.131)	0.681*** (0.144)	0.415*** (0.135)	0.057 (0.085)	0.059 (0.056)
Small-Ticket Costs Did Not Increase, Total Costs Did Not Increase	0.051*** (0.017)	0.170*** (0.037)	0.075*** (0.020)	0.008 (0.007)	0.014 (0.010)
Other Regressors	At mean	At mean	At mean	At mean	At mean
Obs	292	336	336	285	330

Notes: Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1.

In comparison with the analysis on merchants who had a decrease of debit costs, the data show more variation of merchants who had debit cost increases. Table 13 shows a decent size of observations in each of the groups that involve debit cost increases. Specifically, among the 362 one-sector merchants in the sample, 16 percent reported “small-ticket costs increased, total costs increased”; 8 percent reported “small-ticket costs increased, total costs did not increase”; and 9 percent reported “small-ticket costs did not increase, total costs increased.”

Merchant Reactions: Additional Discussions

Our analysis suggests asymmetric merchant reactions to changing debit costs. On the one hand, few merchants in our sample are found to reduce prices or debit restrictions as their debit costs decrease. This is also related to the fact that a relatively small fraction of merchants in our sample reported a decrease of their debit costs in the first place. On the other hand, a sizable fraction of merchants are found to raise prices or debit restrictions as their debit costs increase. Then, a natural question is: What can explain the asymmetry of merchant reactions?

There might be several possibilities. First, our analysis is based on a relatively small sample. While the survey is intended to capture a diversified set of merchants, there is no guarantee that the sample is fully representative. Also because the survey is voluntary, it could be possible that the survey oversampled merchants who were adversely affected by the regulation.

Second, it is not entirely clear how the survey respondents treated inflation or other sector-specific factors that may have influenced the price changes. To address the issue, the survey explicitly asked respondents whether their prices were increased, decreased, or not affected because of Durbin. Presumably, the respondents should tease out any non-Durbin factors that may have affected prices. However, it could still be possible that some respondents may not be able to perfectly identify price changes solely due to the regulation. Therefore, it would be useful if we could control for price changing factors other than Durbin if that data is available.

Third, merchants may indeed have asymmetric reactions to cost changes. In fact, it is a well-documented fact that retail prices tend to respond faster to input cost increases than to decreases (Peltzman 2000). However, since the survey was conducted two years post-regulation, the asymmetric adjustment speed does not seem to provide

Table 13 Variation of Debit Cost Increase Across Merchant Sectors

Merchant Sector	Small-Ticket Costs Increased, Total Costs Increased	Small-Ticket Costs Increased, Total Costs Did Not Increase	Small-Ticket Costs Did Not Increase, Total Costs Increased	Small-Ticket Costs Did Not Increase, Total Costs Did Not Increase
Apparel	17%	9%	13%	61%
Art	0%	13%	13%	75%
Auto	6%	0%	19%	75%
Casinos	0%	50%	0%	50%
Consumer Electronics	8%	8%	8%	75%
Convenience Store	8%	8%	8%	77%
Delivery Services	50%	0%	50%	0%
Department Stores	0%	0%	25%	75%
Discount Retail	46%	8%	0%	46%
Entertainment	15%	5%	5%	75%
Fast Food	33%	10%	8%	48%
Grocery Stores	13%	13%	19%	56%
Home Furnishings	0%	0%	0%	100%
Home Improvement	10%	0%	20%	70%
Hospitality	13%	7%	0%	80%
Maintenance	17%	17%	0%	67%
Medical	11%	5%	11%	74%
Office Products	50%	17%	0%	33%
Other Sector	25%	0%	8%	67%
Real Estate	33%	17%	0%	50%
Restaurants	9%	6%	11%	74%
Services	5%	0%	0%	95%
Sporting Goods	0%	13%	0%	88%
Toys	17%	17%	17%	50%
Transportation	0%	23%	8%	69%
Merchant Average	16%	8%	9%	67%
Sector Average	15%	10%	10%	65%

an adequate explanation.⁹

Finally, it is possible that merchants may also engage in non-price competitions. Therefore, in reaction to a cost reduction, merchants may not necessarily reduce prices but could instead adjust other margins such as providing better quality of services. Of course, these are all conjectures that require further research.

5. CONCLUSION

In this article, we investigate empirical evidence from a merchant survey conducted two years after the debit interchange regulation, introduced by the Durbin Amendment to the Dodd-Frank Act, took effect.

The survey results suggest that the regulation has had a limited and unequal impact on merchants' debit acceptance costs. The majority of merchants in the survey sample (about two-thirds) reported no change or did not know the change of debit costs post-regulation. Some merchants (about a quarter) reported an increase of debit costs, especially for small-ticket transactions. The remaining less than 10 percent of merchants reported a decrease of debit costs. The impact varies substantially across different merchant sectors.

We also find asymmetric merchant reactions in terms of changing prices and debit restrictions. A sizable fraction of merchants are found to raise prices or debit restrictions as their costs of accepting debit cards increase. However, few merchants are found to reduce prices or debit restrictions as debit costs decrease. Further research is needed to understand the asymmetric reactions.

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How Can Consumption-Based Asset-Pricing Models Explain Low Interest Rates?

Felipe Schwartzman

The Great Recession gave way to a period of very low short-term nominal and real interest rates. As the recovery proceeds and the Federal Reserve starts to decide the rhythm with which it intends to raise policy rates, one fundamental question is whether the low interest rates are just a symptom of a recessionary period (even if prolonged) in which the Federal Reserve chose to take a deliberately expansionary stance, or if they reflect longer-run fundamental forces that may not dissipate easily. In the latter case, optimal policy may warrant a slow increase of the policy interest rate, so that it remains low by historical standards even when inflation and the labor market are close to their long-run levels. Currently, Federal Open Market Committee members appear to forecast such a slow increase, as documented in the Summary of Economic Projections.

The purpose of this article is to use consumption-based asset-pricing models to gain some insight into the determinants of the “natural interest rate,” that is, the interest rate that would prevail in the absence of nominal rigidities. Since this natural rate is not itself a function of central bank decisions, it can be used as a yardstick for the stance of monetary policy. In particular, in terms of modern monetary theory (Woodford 2003), one can say that the policy stance is expansionary

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if the interest rate is below the “natural rate of interest” and contractionary otherwise.¹ The question about the optimal pace of interest rate liftoff can thus be recast in terms of the speed with which the natural rate of interest is likely to increase.

Consumption-based asset-pricing models are a natural starting point for the discussion of the fundamental determinants of interest rates for macroeconomists since they share conventional assumptions of most workhorse macroeconomic models: rational expectations, frictionless asset markets, and a representative household. This contrasts with behavioral economics models, which emphasize departures from rational expectations, and with segmented markets models, in which asset prices are determined by only a subset of households.² While these alternatives are certainly worthy of further discussion, the purpose of this article is to provide a first look at the progress that one can make with this more familiar baseline.³ I will review three main strands within the consumption-based asset-pricing literature: habit formation, long-term risk, and disaster risk. Rather than provide a comprehensive review of the literature within each of those strands, I will discuss some of the main ideas based on a small number of influential articles.⁴ At the end of each section I include a short discussion of how the model could be used to explain low interest rates. Those discussions are meant to be illustrative rather than conclusive, in that they delimit promising areas for further research rather than provide a complete answer to how well consumption-based asset-pricing models can explain currently low interest rates.

As we will see in the models reviewed, interest rates can be low either because market participants expect consumption growth to be low, because they perceive consumption risk to be high, or because

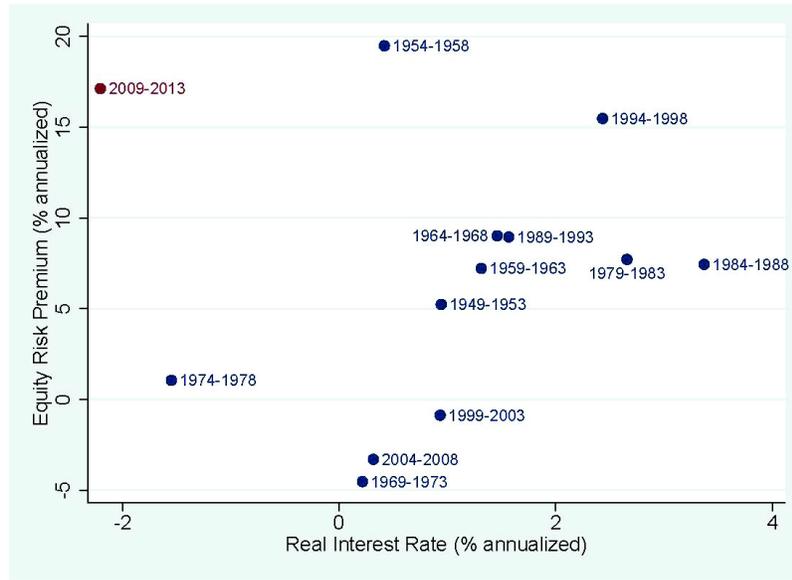
¹ Naturally, the central bank chooses the nominal interest rate, with the real interest rate being determined endogenously, whereas the “natural” rate of interest is typically understood to be a real rate. For more on the link between real and nominal interest rates from a consumption-based asset-pricing perspective, see Sarte (1998) and Wolman (2006).

² In particular, Mehra and Prescott (2008) question the assumption about whether the highly liquid Treasury bill rate is an appropriate measure of the interest rate that households use to save for retirement and smooth consumption.

³ For examples of articles relying on segmented markets to account for the reduction in interest rates post-2008, see Del Negro et al. (2010), Guerrieri and Lorenzoni (2011), and Eggertson and Krugman (2012), and more generally, Vissing-Jørgensen (2002) and Vissing-Jørgensen and Attanasio (2003) for a discussion of how market segmentation affects interest rates. Seminal articles in the behavioral finance literature are Barberis, Shleifer, and Vishny (1998); Daniel, Hirshleifer, and Subrahmanyam (1998); and Hong and Stein (1999). See also Shleifer (2000) and Barberis and Thaler (2003) for reviews.

⁴ In fact, to a large extent the material in this article is a reorganization of material in more detailed reviews by Campbell (2003), Barro and Ursúa (2011), and Cochrane (2011). While this article is written so as to be largely self-contained, the reader is referred to those texts for many of the details (including some of the derivations).

Figure 1 The Equity Premium and the Risk-Free Rate



they have low risk tolerance. In contrast, equity risk premia do not depend on expected consumption growth. Hence, one can gain some insight into the driving force behind low interest rates by examining the behavior of the risk premium. The evolution over time in the two variables can be seen in Figure 1. It depicts the postwar values of the real interest rate, measured by the 30-day Treasury bill rate deflated by the consumer price index, and of the equity risk premium, both of which averaged over various five-year periods.⁵ The five years since the onset of the Great Recession stand out not only because of the exceptionally low real rate of interest, but also because of a historically high equity risk premium. Given the models reviewed, the high risk premium suggests that low interest rates in the recent period are likely to be either a consequence of a perception that consumption risk is particularly high, or of very low risk tolerance.

The article is structured as follows: In the following section, I lay out the notation used in the article as well as common conventions, simplifications, and approximations. Each subsequent section discusses

⁵ To calculate the equity risk premium, I use the value weighted equity returns index from the Center for Research in Security Prices.

one variety of consumption-based asset-pricing models: the Mehra and Prescott (1985) benchmark, the recursive utility and long-run risk extensions of Weil (1989) and Bansal and Yaron (2004), the disaster-risk model of Rietz (1988) and Barro (2006), and Campbell and Cochrane's (1999) habit-formation models. The final section concludes.

1. NOTATION, CONVENTIONS, SIMPLIFICATIONS, AND APPROXIMATIONS

Assets are claims on streams of dividends. In particular, purchasing some asset, i , provides an economic agent with a stochastic stream of dividends $\{D_{t+s}^i\}_{s=0}^{\infty}$ for as long as the agent holds it. In consumption-based asset-pricing models there are no liquidity constraints or other transaction costs, so agents can trade assets freely at each period. If the price of asset i is given by P_t^i , then we can define its return between periods t and $t + 1$ as

$$R_{i,t+1} \equiv \frac{P_{i,t+1} + D_{i,t+1}}{P_{i,t}}. \quad (1)$$

Asset pricing concerns itself either with determining the price-dividend ratio for an asset, $\frac{P_t^i}{D_t^i}$, or its expected returns, $E_t[R_{i,t+1}]$. Typically, higher returns are associated with lower price-dividend ratios.

While the literature discusses the pricing of many kinds of assets, the three main ones are the risk-free asset, a market portfolio of equities, and total wealth. The risk-free asset (denoted by $i = f$) is exactly what the name implies: an asset that pays the same dividend in all states of nature. As an empirical matter, the asset-pricing literature identifies the risk-free asset with short-term Treasury bills. Thus, the predictions of the models under review for the risk-free rate are going to be the most relevant ones for the purpose of monetary policy analysis.

The market portfolio of equities ($i = e$) refers to a well-diversified portfolio of shares issued by firms and traded in stock markets with prices summarized by indices such as the S&P 500. This is, in turn, different from total wealth ($i = w$), which is a fictitious asset (in the sense that there are no formal markets for it) that pays out aggregate consumption as dividends. It includes equity, bonds, housing, and human capital. Oftentimes studies of equity pricing at first identify equity with the wealth portfolio and then in refinements treat the two as distinct. The distinction between equity and the wealth portfolio normally focuses on the fact that firms are leveraged, both because they issue bonds and because salaries are normally insulated from

high-frequency fluctuations in output. Therefore, for any change increase in aggregate endowment, dividends should change by a greater amount. The simplest way of modeling this leverage is to assume that aggregate dividends on equity are a deterministic function of consumption, with $D_t^e = (D_t^w)^\lambda = C_t^\lambda$, for some $\lambda > 1$.

One simplification used by the asset-pricing literature to obtain analytical results is to rely on log normality assumptions. If the log of asset returns is normally distributed, one can use the fact that for any normally distributed x , $E[e^x] = e^{E[x] + \frac{1}{2}Var[x]}$. Thus, if returns $R_{i,t+1}$ are log-normally distributed,

$$\ln(E[R_{i,t+1}]) = E[r_{i,t+1}] + \frac{1}{2}Var[r_{i,t+1}],$$

where we use small letters to denote the natural logarithm.

A further simplification, used in disaster models, is the use of a continuous time formulation to study disaster risk. Denote by dt the length of a period of time. Let $e^{r_{i,t+1}dt}$ be the gross return per period of time of that asset. Suppose the return on some asset i is either $e^{\bar{r}dt}$ with probability e^{-pdt} or $(1 - b)e^{\bar{r}dt}$ with probability $1 - e^{-pdt}$. Then

$$E[e^{r_{i,t+dt}dt}] = [e^{-pdt} + (1 - e^{-pdt})(1 - b)] e^{\bar{r}dt}.$$

Taking logs and dividing by dt yields

$$\frac{\ln E[e^{r_{i,t+dt}dt}]}{dt} = \bar{r} + \frac{\ln [e^{-pdt} + (1 - e^{-pdt})(1 - b)]}{dt}.$$

Taking the limit as $dt \rightarrow 0$ and applying l'Hopital's rule,

$$E[r_{i,t+dt}] = \bar{r} - pb.$$

The continuous time approximation yields an intuitive expression for expected log returns. Those are equal to \bar{r} , except that with probability p they fall by b .

Finally, a common approximation used in the analytical literature is to log-linearize equation (1) to obtain

$$r_{i,t+1} = \rho p i_{t+1} + (1 - \rho) d_{i,t+1} - p_{i,t},$$

where ρ is the average $\frac{P}{P+D}$ ratio and is typically calibrated to some value close to 1. Rearranging and iterating forward up to some time $t + T$ with $T > 0$ yields

$$p_{i,t} - d_{i,t} = \sum_{s=0}^T \rho^s \Delta d_{t+1+s} - \sum_{s=0}^T \rho^s r_{i,t+1+s} + \rho^{T+1} p_{i,T+1}.$$

The expression is useful in that it breaks down three different determinants of the price-dividend ratio. The first term on the right-hand side is a discounted sum of future dividends growth. The faster dividends are expected to grow, the more a portfolio that pays off the consumption good as dividends is worth. The second term is a discounted sum of returns. All else constant, if prices are low in spite of high dividend growth, then the returns will be high as prices catch up with dividends. The third term is a “bubble” term. In most asset-pricing applications, one assumes that the bubble term goes to zero almost as surely as T increases. Given the no-bubble condition,

$$p_{i,t} - d_{i,t} = \sum_{s=0}^{\infty} \rho^s \Delta d_{t+1+s} - \sum_{s=0}^{\infty} \rho^s r_{i,t+1+s}.$$

The equation highlights that a high price-dividend ratio can forecast either a high growth in dividend payments or low future rates of returns.

Taking expectations and rearranging,

$$\begin{aligned} & (E_{t+1} - E_t) r_{i,t+1} \\ &= (E_{t+1} - E_t) \sum_{s=0}^{\infty} \rho^s \Delta d_{t+1+s} - (E_{t+1} - E_t) \sum_{s=1}^{\infty} \rho^s r_{i,t+1+s}, \quad (2) \end{aligned}$$

where $(E_{t+1} - E_t) r_{i,t+1} \equiv r_{i,t+1} - E_t r_{i,t+1}$ denotes the surprise in returns. The latter equation is useful to assess the sources of volatility in an asset return. It emphasizes that the volatility in returns for any asset can be a function of either the volatility of news concerning its future dividend flows or news concerning its future returns.

2. THE MEHRA AND PRESCOTT BENCHMARK

We start by examining a simplified version of the power utility benchmark case examined by Mehra and Prescott (1985). This corresponds to the common setup in macroeconomic models in which households are endowed with a separable power utility of consumption. As commonly done in the finance literature, Mehra and Prescott follow Lucas (1978) and focus on the case of an endowment economy in which households

consume and trade claims on immediately perishable fruits that fall from an infinitely lived tree.⁶

Individual households determine how much to consume in each period of time and how much to invest in a portfolio of assets that it has available. We assume that there are N different assets, indexed $i \in \{1, \dots, N\}$, and that those assets completely span the shocks that the households are subject to so that markets are complete. The problem of the household is

$$\begin{aligned} & \max_{\{x_t^i\}_{(t,i)=(0,1)}^{(\infty,N)}} E_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma} - 1}{1-\gamma} \right] \\ \text{s.t. : } & C_t + \sum_{i=1}^N P_{i,t} x_{i,t} = \sum_{i=1}^N x_{i,t-1} (P_{i,t} + D_{i,t}), \end{aligned}$$

where x_t^i is the amount of shares of asset i held by the household at time t and, as before, P_t^i is the realized price and D_t^i is its realized dividend. The parameter γ is the coefficient of relative risk aversion and governs the tolerance that households have for risk. It is also the inverse of the intertemporal elasticity of substitution, governing the household’s desire to smooth consumption over time. The optimality condition for the household is

$$P_{i,t} C_t^{-\gamma} = \beta E_t \left[C_{t+1}^{-\gamma} (P_{i,t+1} + D_{i,t+1}) \right].$$

Let $R_{i,t+1} \equiv \frac{P_{i,t+1} + D_{i,t+1}}{P_{i,t}}$ be the return on asset i . Returns, like prices, are equilibrium objects determined endogenously. Given expected future prices and dividends, higher returns are tied to lower prices at t . Given the definition of returns and the optimality condition, we have that

$$1 = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} R_{i,t+1} \right]. \tag{3}$$

The ratio of marginal utilities $\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}$ is the *pricing kernel* in this economy. In order to hold a positive and finite amount of an

⁶ The analysis of asset-pricing models to environments with production (“Production Based Asset Pricing”) is itself an active area of research that we will leave undiscussed. For important contributions in that literature, see Cochrane (1991); Jermann (1998); Boldrin, Christiano, and Fisher (2001); and Gomes, Kogan, and Zhang (2002), among many others.

asset, a risk-neutral household ($\gamma = 0$) requires that the return of the asset i be, on average, equal to β^{-1} irrespective of its variance. If $\gamma > 0$, the household instead requires β^{-1} to be equal to a weighted average of returns, giving more weight to states of the world where its consumption growth is lowest. The implication of this weighting is easiest to see if one rewrites equation (3) as

$$\beta^{-1} = E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right] E_t [R_t^i] + \text{cov} \left(\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}, R_t^i \right).$$

Suppose there is a risk-free asset, denoted by $i = f$, so that $\text{var} (R_t^f) = 0$. Then

$$R_t^f = \frac{\beta^{-1}}{E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right]}, \quad (4)$$

and

$$\frac{E_t [R_t^i] - R_t^f}{R_t^f} = -\beta \text{cov} \left(\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma}, R_t^i \right), \quad (5)$$

so that households request a higher premium over the risk-free rate for assets in which the covariance between the pricing kernel and the rate of returns is negative. It is possible to express equations (4) and (5) in log-linear form if one is willing to assume that the logs of consumption growth and asset returns are normally distributed. Then,

$$E_t [r_{i,t+1}] - r_{f,t+1} + \frac{\sigma_i^2}{2} = \gamma \sigma_{ic}, \quad (6)$$

with

$$r_{f,t+1} = -\log \beta + \gamma E_t \Delta c_{t+1} - \frac{\gamma^2 \sigma_c^2}{2}, \quad (7)$$

where $r_{i,t+1}$ are the log returns on asset i , $r_{f,t+1}$ are the log returns on the risk-free asset, σ_i^2 is the variance of the logarithm of the returns on asset i , σ_c^2 is the variance on the logarithm of consumption growth, and σ_{ic} is the covariance between log returns and log consumption growth.

The first two terms on the left-hand side of equation (6) are just the differences between the expected return on some asset i and the risk-free asset. The third term is a Jensen's inequality adjustment term, accounting for the fact that, since logarithm is a concave function, the

logarithm of an expected variable is always larger than the expectation of the logarithm.⁷ The term on the right-hand side has two components. The second, σ_{ic} , is the covariance between the asset return and consumption growth and can be interpreted as the “quantity of risk” in the asset. The first, γ , is the coefficient of relative risk aversion and it can be interpreted as the “price” of risk. Under power utility, the price of risk is constant, and asset prices only depend on the risk one period ahead.

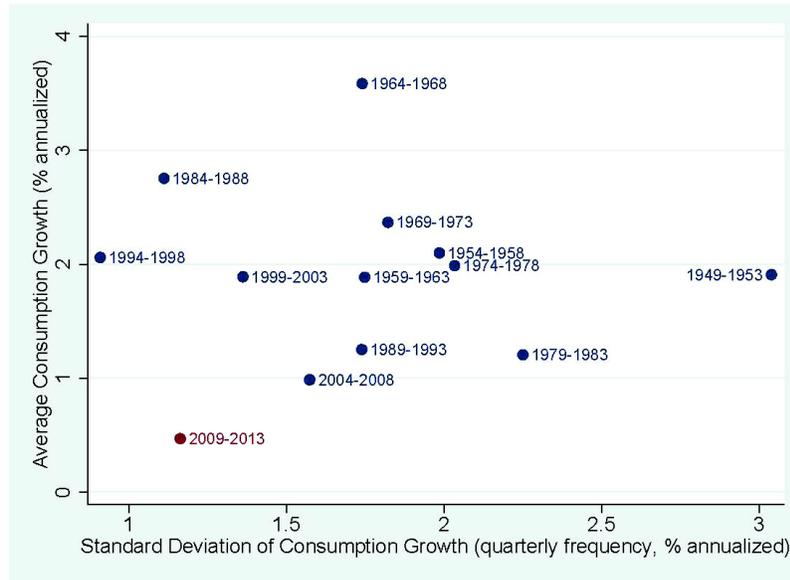
As famously demonstrated by Mehra and Prescott (1985), the model performs poorly in quantitative terms. In their baseline exercise, they equate equity with the wealth portfolio, i.e., an asset that pays out aggregate consumption as dividends.⁸ Given that consumption growth does not vary much, the quantity of risk σ_{ic} is very low. Because of that, Mehra and Prescott find that for reasonable values of γ (10 and under), the equity risk premium implied by the right-hand side of equation (6) is an order of magnitude smaller than the one found in the data. This observation has spurred a very large literature and is a cornerstone of modern asset-pricing research.

For a large enough γ , the model is of course able to match the equity premium. However, setting γ to a very large number also has implications for the risk-free rate that do not fit the data. In an average quarter, consumption growth $E_t [\Delta c_{t+1}]$ is close to 2 percent in yearly terms and the standard deviation has a similar magnitude. If we take the coefficient of risk aversion to be $\gamma = 10$, close to Mehra and Prescott’s upper bound, then matching the risk-free rate of 1 percent in yearly terms would require a discount rate of close to -19 percent per year. In a period of time where expected consumption is 1 percent instead of 2 percent, the interest rate would fall from 1 percent to -9 percent.

Intuitively, the reason for the tradeoff between matching the high risk premium and the low interest rate is that γ captures how unwilling households are to let consumption vary, be it over time or between states of nature. The higher γ , the more households dislike variation in consumption along either dimension. Hence, if a household with a high γ foresees that its consumption will grow slower, it will be very willing to borrow in order to keep consumption smoothed out over time. In equilibrium, this leads to a sharp reduction in the interest rate.

⁷ Formally, Jensen’s inequality states that if g is a concave (convex) function, then $g(E[x]) > (<) E[g(x)]$. In that specific case, the left-hand side is $\log\left(E\left[\frac{R_{i,t+1}}{R_{f,t+1}}\right]\right) > E\left[\log\left[\frac{R_{i,t+1}}{R_{f,t+1}}\right]\right] = E_t[r_{i,t+1}] - r_{f,t+1}$.

⁸ As a robustness, they also consider the case where leverage increases the volatility of equities.

Figure 2 Consumption Growth and Risk

Implications for the Interest Rate in the Recent Period

While, in quantitative terms, the Mehra and Prescott benchmark fails as an explanation of asset pricing, it is still a useful benchmark in that it highlights which factors are likely to matter for interest rates in consumption-based asset-pricing models. In what follows, I use this benchmark as a qualitative guide to the factors driving the risk-free interest rate and show how they have evolved in the current recession. For convenience, I restate equation (6) for the risk-free rate below:

$$r_{f,t+1} = -\log \beta + \gamma E_t \Delta c_{t+1} - \frac{\gamma^2 \sigma_c^2}{2}. \quad (8)$$

As equation (8) makes clear, interest rates can either be low because market participants expect consumption growth to be low or because they perceive consumption risk to be high.

Figure 2 shows the average and standard deviations of quarterly consumption growths, both expressed in annualized terms and averaged

over various five-year periods.⁹ While 2009–13 does feature exceptionally low consumption growth for historical standards, it also features exceptionally low consumption variance. Hence, in qualitative terms, the model would have to account for the low interest rates through low expected consumption growth.

It is worth highlighting that, given the Mehra and Prescott (1985) benchmark, there is a tension between Figures 1 and 2, since equation (6) implies that, if consumption is correlated with dividends, a high variance of consumption growth ought to be associated with a high equity premium.¹⁰ In contrast, we observe a low variance of consumption growth and a high equity premium. As we will see, alternative consumption-based asset-pricing models can provide potential resolutions to this inconsistency, as they allow either for the possibility that the “price” of risk may be changing (as in habit formation models) or that the kind of short-term consumption risk depicted in Figure 2 may not be the best measure of the kind of risk that asset holders are mostly concerned with when making their portfolio decisions.

3. RECURSIVE UTILITY AND LONG-RUN RISK

As discussed above, a major challenge facing common power-utility models is the difficulty in matching both households’ willingness to let their consumption change over time (captured by a low interest rate) and their unwillingness to let it vary across states of nature (captured by the high equity risk premium). One possible solution to this tension is to allow for the possibility that the desire for intertemporal smoothing is governed by a different parameter than the desire for insurance. This is provided by the recursive utility function proposed by Epstein and Zin (1989) and Weil (1989, 1990), based on prior work by Kreps and Porteus (1978). In particular, the recursive utility function

⁹ The consumption series is taken from Martin Lettau’s website and is defined in Lettau and Ludvigson (2001). In particular, it excludes durable goods, shoes, and clothing.

¹⁰ Consumption variance is an important factor in explaining the equity risk premium under the assumption that that consumption growth is i.i.d. and that growth in stock dividends is perfectly correlated with consumption growth, so that $\Delta d_{e,t} = \lambda \Delta c_{e,t}$. Then, if we guess that equity returns are also i.i.d., from equation (2) we have that

$$(E_{t+1} - E_t) r_{e,t+1} = (E_{t+1} - E_t) \Delta d_{t+1}.$$

Since dividend growth is i.i.d., the guess that equity returns are i.i.d. is verified. In this case, the covariance between consumption and equity returns σ_{ec} is simply $\lambda var(\Delta c_{e,t})$. Hence, from equation (6), higher consumption variance is associated with a higher equity risk premium.

provides for the representation of preferences over lotteries in which agents rank them in terms of the time in which uncertainty is resolved. For example, an agent may face two different lotteries that pay the same amounts at some distant date depending on the flip of a coin, but in one lottery the coin flip takes place immediately, whereas in the other it only takes place much later. Under this kind of preference, agents may prefer the first lottery to the second even though the distribution of outcomes is identical.¹¹ The Epstein-Zin-Weil (EZW) utility function can be written as

$$U_t = \left\{ (1 - \beta) [C_t]^{1 - \frac{1}{\psi}} + \beta \left[\left(E_t U_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1 - \frac{1}{\psi}} \right\}^{\frac{1}{1 - \frac{1}{\psi}}}, \quad (9)$$

where U_t is the utility at time t . Preferences for early resolution of uncertainty emerge if $\frac{1}{\psi} < \gamma$.

The parameter ψ can be interpreted as the intertemporal elasticity of substitution. This interpretation becomes most clear in the deterministic case. Without uncertainty, the exponents in $1 - \gamma$ around U_{t+1} cancel out and, with a slight rearrangement, equation (9) collapses to the usual Bellman equation format, with period utility of consumption given by $C_t^{1 - \frac{1}{\psi}}$.

The parameter γ can be interpreted as a risk-aversion parameter. Heuristically, this can be seen in a version of the problem where the household only consumes in $t = 2$ so that there are no intertemporal choices to be made. Then, $U_t = 0$ for $t > 2$, $U_2 = C_2$, and $U_1 = \beta^{\frac{1}{1 - \frac{1}{\psi}}} E_t \left[C_2^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$, so that the problem of the household is equivalent to maximizing expected utility $E_t \left[C_2^{1-\gamma} \right]$.¹²

Finally, it is also straightforward to check that, if $\frac{1}{\psi} = \gamma$, equation (9) collapses back to a recursive version of the benchmark power-utility case, in which the coefficient of relative risk aversion is equal to the inverse of the intertemporal elasticity of substitution.

Given this utility function, one can derive the following Euler equation for portfolio decisions:¹³

¹¹ This is a violation of the independence axiom for preferences so that with Epstein-Zin-Weil preferences, utility will not necessarily be separable across states of nature.

¹² Strictly speaking, for this example we would need $\psi < 1$, so that the utility function is still well defined for $C_t = 0$.

¹³ See the Appendix for a derivation.

$$1 = E_t \left[\left\{ \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}} \right\}^\theta \left(\frac{1}{R_{w,t+1}} \right)^{1-\theta} R_{i,t+1} \right], \quad (10)$$

where $R_{w,t+1}$ is the return on total household wealth and $\theta \equiv \frac{1-\gamma}{1-\frac{1}{\psi}}$, so that in the benchmark power-utility case, $\theta = 1$. The pricing kernel is $\left\{ \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}} \right\}^\theta \left(\frac{1}{R_{w,t+1}} \right)^{1-\theta}$ and is a weighted average of the pricing kernel obtained in the benchmark separable utility case and the reciprocal of the return on wealth, $R_{w,t+1}$. The return on wealth in the pricing kernel captures the impact of news about future consumption on agent's marginal utility. To see this, recall that, from equation (2), surprises in the returns to the wealth portfolio satisfy

$$\begin{aligned} & (E_{t+1} - E_t) r_{w,t+1} \\ &= (E_{t+1} - E_t) \sum_{s=0}^{\infty} \rho^s \Delta c_{t+1+s} - (E_{t+1} - E_t) \sum_{s=1}^{\infty} \rho^s r_{w,t+1+s}, \end{aligned} \quad (11)$$

where we use the fact that, by definition, the dividends on the wealth portfolio are equal to aggregate consumption. Thus, surprises to the returns on wealth reflect surprises in future consumption growth, discounted by surprises to the future returns on wealth itself.

The reason why returns on wealth are factors in the pricing kernel under EZW preferences is because of the nonseparability between utility for current and future consumption. With power utility, preferences are separable. Given that agents are able to completely change their portfolio each period, they need not concern themselves with consumption flows in the far future when evaluating which portfolio to hold between two adjacent periods. This is no longer true with EZW preferences.

If the logs of consumption growth and returns are normally distributed, we can write the following expression for the risk premium associated with any given asset i :

$$E_t r_{i,t+1} - r_{f,t+1} + \frac{\sigma_i^2}{2} = \theta \frac{\sigma_{ic}}{\psi} + (1 - \theta) \sigma_{iw}, \quad (12)$$

and for the risk-free rate,

$$r_{f,t+1} = -\log \beta + \frac{1}{\psi} E_t [\Delta c_{t+1}] + \frac{\theta - 1}{2} \sigma_w^2 - \frac{\theta}{2\psi^2} \sigma_c^2, \quad (13)$$

where now σ_{iw} is the covariance between the returns on asset i and the return on total household wealth, and σ_w^2 is the variance of the total returns on wealth.

Recursive preferences allow one to account for the equity premium puzzle in two ways. First, as highlighted by Weil (1989), there is no longer a tradeoff between matching the equity risk premium and the risk-free rate, as there is an additional parameter to be calibrated. Furthermore, as explored in detail by Bansal and Yaron (2004), with $\theta \neq 1$, the covariance of the asset return with the return on total wealth σ_{iw} becomes an additional factor in determining the equity premium. Thus, if, for example, the variation in total return on wealth is similar to the variation in equity returns, then returns on total wealth are clearly much more volatile than consumption, so that σ_{iw} is potentially much larger than σ_{ic} .

One problem with evaluating equations (12) and (13) is that the variance of total wealth is hard to measure since total wealth includes human capital. One can make some progress by imposing structure on the process for consumption. In particular, suppose that the consumption growth Δc_{t+1} is the sum of a predictable component z_t and an unpredictable one $\epsilon_{c,t+1}$ as in

$$\begin{aligned}\Delta c_{t+1} &= z_t + \sigma_c \epsilon_{c,t+1} \\ z_{t+1} &= (1 - \phi)g + \phi z_t + \sigma_z \epsilon_{z,t+1},\end{aligned}$$

with $\epsilon_{c,t+1}$ and $\epsilon_{z,t+1}$ i.i.d. standard normal variables.¹⁴ With ϕ close to 1 and high σ_c , this structure allows for consumption growth to have a predictable, stochastic, long-term component, even if at high frequencies overall consumption growth is hard to predict.¹⁵ For the wealth portfolio, the dividends are equal to aggregate consumption, so that $R_{w,t} = \frac{P_{w,t+1} + C_{t+1}}{P_{w,t}}$. From equations (12) and (13) we have that, if risk doesn't vary over time (so that it is homoscedastic), then

$$E_t r_{w,t+1} = \mu + \frac{1}{\psi} E_t [\Delta c_{t+1}],$$

where μ is a constant that depends on the variances. This allows us to substitute out the returns from the right-hand side of equation (2) to obtain

¹⁴ It is straightforward but tedious to allow for correlation between $\epsilon_{c,t+1}$ and $\epsilon_{z,t+1}$, so we will assume that they are uncorrelated.

¹⁵ The question of whether or not consumption growth rate has a persistent component is hard to settle, since ϕ is hard to estimate in small samples. Bansal and Yaron (2004) show that a large ϕ is not inconsistent with observed autocovariance of consumption growth and observed variances of consumption growth at different horizons.

$$\begin{aligned}
& (E_{t+1} - E_t) r_{t+1}^w \\
= & (E_{t+1} - E_t) \Delta c_{t+1+s} \\
& + \left(1 - \frac{1}{\psi}\right) (E_{t+1} - E_t) \sum_{s=1}^{\infty} \rho^s \Delta c_{t+1+s}. \tag{14}
\end{aligned}$$

We can now use the expression just derived to describe the sources of one-step-ahead variation in returns to the wealth portfolio. The first component on the right-hand side is the innovation in consumption growth, with variance σ_c^2 . The second component is a discounted sum of future consumption growth. It changes as news about future consumption growth arrives, in the form of innovations to z_{t+1} . This second component incorporating news about future consumption is what allows returns on the wealth portfolio, and hence the pricing kernel, to be significantly more volatile than consumption growth. If, instead, consumption growth were i.i.d. so that this component would be equal to zero, the variance of returns on wealth would be as small as the variance of consumption growth. The higher variance of the pricing kernel associated with persistence in consumption growth is what allows models with EZW preferences to imply substantially larger risk premia than models with power utility for a given value of the risk-aversion parameter γ , as one can see from equations (12) and (13) determining the risk premium and the risk-free rate.

Bansal and Yaron (2004) emphasize that a reasonable parameterization of the model requires both $\gamma > 1$ and $\psi > 1$. They choose $\gamma = 10$, at the upper bound of Mehra and Prescott's (1985) exercise, and $\psi = 1.5$. The choice of ψ is subject to debate, as many empirical studies of consumption behavior over time point to very low values for ψ . Bansal and Yaron (2004) counter that stochastic variance in consumption introduces a downward bias in estimates of ψ and that, furthermore, studies with more disaggregated consumption data support lower ψ . Importantly, they also point out that one can discipline the value of ψ through the correlation between asset prices and news about consumption growth and consumption volatility. This can be seen in equation (14), where, with $\psi > 1$, news about future consumption growth leads to an increase in the returns on wealth, but with $\psi < 1$ such news leads to a reduction.

As emphasized by Bansal and Yaron (2004), recursive preferences imply that risk premia vary not only with news about future consumption growth, but also with news about its variance. A higher variance of innovations to future consumption growth increases the variance of returns on the wealth portfolio and, hence, of the pricing kernel, leading to a higher equity premium and lower risk-free rates. Therefore,

time variation in the variance of long-run growth (“long-run risk”) can be an important factor explaining the variance in risk premia observed in the data.

Implications for the Interest Rate in the Recent Period

For convenience, I restate the equation describing the determinants of the risk-free rate:

$$r_{f,t+1} = -\log \beta + \frac{1}{\psi} E_t [\Delta c_{t+1}] + \frac{\theta - 1}{2} \sigma_w^2 - \frac{\theta}{2\psi^2} \sigma_c^2.$$

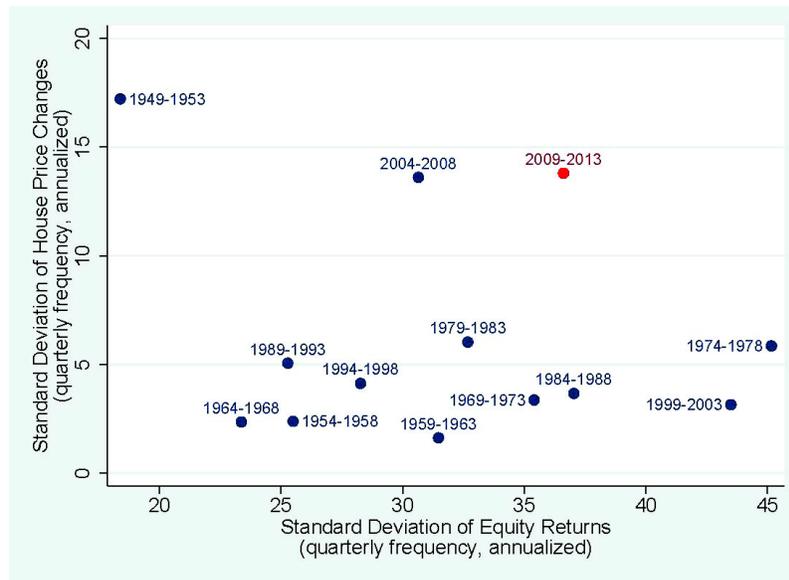
Note that under the calibration adopted by Bansal and Yaron (2004), $\frac{1}{\psi} = \frac{2}{3}$, $\frac{\theta-1}{2} = -14$, and $\frac{\theta}{2\psi^2} = -6$, so that the weight placed on the two risk factors is comparatively large. This equation holds for the case of homoscedastic risk. Bansal and Yaron (2004) also provide a derivation of the risk-free rate when risk is time varying so that σ_w^2 and σ_c^2 are functions of time. In that case, the coefficients change but the essential factors determining the risk-free rate remain the same.¹⁶

The recursive preferences model implies that the risk-free rate changes not only with the expected growth rate of consumption or with the variance of that growth rate, but also with changes in the mean and variance of returns on wealth, σ_w^2 . As previously discussed, these are, in turn, functions of the variance of the long-term component of consumption growth. Given the calibration advocated by Bansal and Yaron (2004), a reduction in the interest rate could thus stem not only from the same factors that explain the reduction in interest rates in the benchmark time-separable model, but also from an increase in the variance of the long-run component of consumption growth.

Total wealth in the economy includes not only equity in firms, but also housing and human capital. Figure 3 depicts the volatilities of equity returns and house price increases over five-year periods.¹⁷ Both volatilities were high by historical standards in the 2009–13 period, most notably the volatility of housing returns. Thus, long-run risk could, in principle, help explain the low interest rates while accounting for the disconnect between high risk premia and the low volatility of consumption growth in that period. More generally, however, the

¹⁶ Bansal and Yaron consider a case in which there is only one stochastic risk factor so that σ_w^2 and σ_c^2 co-move perfectly.

¹⁷ The housing price data is from Shiller (2015). House price increases are a good approximation for housing returns so long as rents are stable.

Figure 3 Wealth Risk

correlation between these volatilities and the equity premium is questionable. For example, the 2004–08 period exhibits very high house price volatility even as the equity risk premium is very low (see Figure 1). Likewise, the 1999–2003 period exhibits very low equity risk premia together with a very volatile equity premium. Naturally, these are only rough correlations based on period averages using arbitrary cutoffs, so this should not be seen as grounds for rejecting the long-run risk model. Also, we have ignored the hard to measure contribution of volatility in returns to human capital.

4. DISASTER RISK

One early reaction to Mehra and Prescott's (1985) equity premium puzzle is that the distribution of asset returns and consumption growth is prone to rare but large disasters. If those disasters are likely to have a larger impact on the dividends paid out by equities than on the return on sovereign bonds, they can generate a large premium between stocks and bonds as private agents seek to insure themselves against those rare occurrences.

The argument was first put forward by Rietz (1988). Barro (2006) makes a case for the argument by using international data to

calculate the probabilities and magnitudes of large disasters, putting a 1.7 percent probability of a collapse in consumption of, on average, 30 percent.¹⁸ He also calculates the probability of sovereign default in the event of a disaster and the recovery rate that investors can expect in those events. He finds that with a coefficient of relative risk aversion as small as four and a discount rate of 3 percent per year, it is possible to obtain equity premia and risk-free rates that are closer to the data.

Barro (2006, 2009) considers an environment where the aggregate endowment follows a random walk with drift g and variance σ_c^2 most of the time, but with probability p it collapses permanently to a fraction $1 - b$ of its value, where b is itself a random variable drawn from the empirical distribution of disasters that he documents. Taking a continuous-time limit, Barro (2009) arrives at expressions that, after a substitution, yield the following expressions for the risk-free rate:¹⁹

$$r^f = -\log \beta + \gamma g - \frac{1}{2} \gamma^2 \sigma^2 - p [E(1 - b)^{-\gamma} - 1],$$

and, if one takes, as he does, equity to incorporate all of the wealth portfolio, for the risk premium:

$$r^e - r^f = \gamma \sigma^2 + p [E(1 - b)^{-\gamma} - E(1 - b)^{1-\gamma} - E[b]].$$

Thus, an increase in the probability of disasters leads to a reduction in the riskless rate and an increase in the equity risk premium. One important result is that asset returns are nonlinear functions of the size of disasters b . This enhances the ability of disasters generating large risk premia and low interest rates since, as b approaches 1, the marginal utility of consumption in the disaster state approaches infinity. Furthermore, as emphasized by Barro, the model can accommodate “bonanzas,” which are as large as the disasters and still generate large risk premia, since households will be much more concerned with the disaster states (in which they have high marginal utility) than with the bonanza states (in which their marginal utility is low).

Barro and Ursúa (2011) provide a comprehensive review of the small literature that has emerged around the notion of disaster risk being a key driver of asset-pricing data. This literature has expanded the model

¹⁸ In particular, Barro defines a disaster as an event in which gross domestic product (GDP) drops by 15 percent or more, and equate the change in consumption with the observed change in GDP.

¹⁹ The substitution in question is from the expected consumption growth $E_t \left[\frac{C_{t+1} - C_t}{C_t} \right]$ (denoted g^* in Barro [2009]) for its determinants, $g + \frac{1}{2} \sigma^2 - p \times E[b]$. The substitution singles out g since it is likely to be closer to observed average log consumption growth than g^* .

to allow for time-varying disaster risk, thus allowing it to explain time-varying risk premia (Gourio 2010), and disasters that are correlated across countries and happen slowly rather than quickly (Nakamura et al. 2010), as well as to evaluate implications of the model for additional asset pricing facts (Gabaix 2008).

Implications for the Interest Rate in the Recent Period

For convenience, I restate the equation describing the determinants of the risk-free rate:

$$r^f = -\log \beta + \gamma g - \frac{1}{2} \gamma^2 \sigma^2 - p [E (1 - b)^{-\gamma} - 1] .$$

In addition to the determinants of interest rates in the other models (expected growth and one-step-ahead volatility of consumption), models with economic disasters imply that interest rates ought to change in response to changes in the probability of disaster or to changes in the expected size of disasters.

It is plausible that, in the aftermath of the Great Recession, economic agents have updated upward their subjective probabilities of such an episode occurring again. This could go some way in explaining the smaller interest rate observed in the recent period. In particular, consumption dropped 2.7 percent between Q2:2007 and Q4:2009. Relative to a 2 percent per year trend, the reduction was 7.9 percent. Suppose that, given that observation, agents assign a probability of 5 percent to a drop in consumption of 5 percent in any given period, so that such a disaster occurs on average every 20 years.²⁰ Then, if they have a risk aversion of four, they will request a risk-free rate that is $0.05 (0.95^{-4} - 1) = 1.14$ percent in yearly terms smaller than before. This revision is unlikely to dissipate very quickly since, given the small probabilities of a disaster occurring, the fact that another one hasn't come to fruition should weigh little on the probability assessment. Importantly, apart from helping explain the lower interest rate, the disaster risk could allow one in principle to reconcile the low volatility of

²⁰ A 5 percent probability would be high compared to the 1.7 percent calculated by Barro (2006), but, in contrast, the reduction in consumption of 5 percent is less extreme than the average 30 percent reduction found in that study. One obvious caveat is that the drop in consumption occurred smoothly, over two and a half years, whereas the model assumes that the whole change occurs instantaneously. Nakamura et al. (2010) show how the rare disaster model can accommodate slow disasters if agents have EZW preferences.

consumption with the high equity premium in the post-Great Recession era.

5. HABITS

In both the discussion of rare disasters and long-term risk, the time variation in expected risk premia is understood primarily as stemming from time variation in the quantity of risk that households face. Under habit formation, this same time variation is explained as stemming from variation in the risk tolerance of households, which determines the price of risk.

In habit-formation models, the marginal utility of consumption depends on a time-varying state variable that evolves as a function of past consumption decisions. The key idea is that as households become habituated to certain consumption levels, their marginal utility of consumption becomes higher for a given level of consumption. Habit-formation models differ along several dimensions, including whether habits are “internal” (where habit depends on individual household consumption) or “external” (where habit depends on aggregate consumption), whether habits enter in the utility function multiplicatively or additively, and whether habits change more or less quickly with consumption.²¹ In what follows, we discuss the model by Campbell and Cochrane (1999).

Campbell and Cochrane (1999) point out that habit models are successful in generating volatile time-varying risk premia because they increase the volatility of the marginal utility of consumption. They assume habits enter additively and are “external” so that

$$u(C_t, X_t) = \frac{(C_t - X_t)^{1-\gamma} - 1}{1-\gamma},$$

where X_t is the stock of habits. Then the curvature of the utility function with respect to C_t is given by

$$\frac{u_{cc}(C_t, X_t) C_t}{u_c(C_t, X_t)} = -\frac{\gamma}{S_t},$$

where $S_t \equiv \frac{C_t - X_t}{C_t}$ is “surplus consumption,” the gap between consumption and the habit. It follows that the curvature is higher in absolute

²¹ See Campbell (2003) for a more detailed discussion. Models of habits in finance include Sundaresan (1989), Abel (1990, 1999), Constantinides (1990), and Campbell and Cochrane (1999), among others.

terms when consumption is closest to its habit level X_t . This time-varying curvature implies that the pricing kernel $\frac{u_c(C_{t+1}, X_{t+1})}{u_c(C_t, X_t)}$ is also likely to vary with S_t .

To complete the specification of preferences, Campbell and Cochrane (1999) need to specify how habits evolve over time. Rather than using a more conventional specification in which the habit stock X_t evolves as a log-linear function of C_t , they recur to a nonlinear specification in which S_t is a log-linear function of changes in $\log C_t$. One advantage of this specification is that it ensures that surplus consumption S_t is always positive, which is necessary for the utility to be well defined. They define the evolution of surplus consumption to be given by

$$s_{t+1} = \phi \bar{s} + (1 - \phi) s_{t-1} + \lambda(s_t) (c_{t+1} - c_t - E[c_t]),$$

where \bar{S} is the steady-state level of the habit (and \bar{s} its log), and $\lambda(s_t)$ is a nonlinear function of s_t . The nonlinear term $\lambda(s_t)$ helps them deal with one important difficulty with habit-formation models. This is that, while a time-varying pricing kernel helps generate volatile expected risk premia, it can also give rise to counterfactually volatile interest rates. In Campbell and Cochrane’s specification, the risk-free rate is given by

$$r_t^f = -\ln(\beta) + \gamma E_t[\Delta c_{t+1}] - \gamma(1 - \phi)(s_t - \bar{s}) - \frac{\gamma^2 \sigma^2}{2} [1 + \lambda(s_t)]^2.$$

The first two terms are the ones obtained in a model without habits. The following two include the effect of habits. The third term summarizes the effect of habits on intertemporal substitution. Surplus consumption is expected to mean revert at the rate $1 - \phi$. If it is above its steady-state levels, then households expect it to become smaller over time, which is to say that they expect their marginal utility to become smaller. Thus, they become more patient, leading to a smaller equilibrium risk-free rate. The last term on the right-hand side captures the effect of consumption risk on the risk-free rate. Now, apart from the usual reason through which consumption risk generates precautionary savings, households also seek to keep their consumption risk low because it is correlated with their habit formation. In periods in which realizations of consumption are high, surplus consumption also increases.

Campbell and Cochrane (1999) discipline their choice of $\lambda(s_t)$ by adding three requirements. Two of them are technical. They impose that X_t is pre-determined in steady state and that it is always increasing in shocks to c_t . These conditions ensure that, close to steady state, their process for habits resembles more common specifications. The

third requirement is that risk-free rates do not vary with habits. Thus, by construction, their model delivers a low volatility for the risk-free rates, as in the data. This allows them to focus more sharply on the variation in risk premia. Given Campbell and Cochrane's (1999) calibration, the interest rate is

$$r_{t+1}^f = -\log(\beta) + \gamma E_t[\Delta c_{t+1}] - \left(\frac{\gamma}{\bar{S}}\right)^2 \frac{\sigma_c^2}{2}.$$

Note that $\frac{\gamma}{\bar{S}}$ is the curvature of the utility function with respect to consumption in steady state and is thus a measure of the risk tolerance of households. If $\bar{S} < 1$, it is possible for the model to have a large steady-state curvature with respect to consumption ($\frac{\gamma}{\bar{S}}$), leading to high risk premia, even if it has a relatively low γ . This, in turn, allows it to admit more moderate interest rates. Specifically, Campbell and Cochrane calibrate $\gamma = 2.372$ and $\bar{S} = 0.049$, so that the curvature of the utility function close to steady state is approximately equal to 48.

Campbell and Cochrane (1995) also consider an extension of the model in which they choose $\lambda(s_t)$ to ensure that risk-free rates are a linear function of log habits, decreasing when surplus consumption is high. They pick the intercept to correspond to a 1 percent real interest rate and the slope so that the lower bound for the real interest rate is zero.

Implications for the Interest Rate in the Recent Period

For convenience, I restate the equation describing the determinants of the risk-free rate:

$$r_{t+1}^f = -\log(\beta) + \gamma E_t[\Delta c_{t+1}] - \left(\frac{\gamma}{\bar{S}}\right)^2 \frac{\sigma_c^2}{2}.$$

As calibrated by Campbell and Cochrane, the factors determining the real interest rate in the model with habits are the same as in the Mehra and Prescott (1985) benchmark, the only difference being that the model with habits assigns a greater weight to consumption volatility.

The models with long-run or disaster risk are able to explain the reduced interest rate with the introduction of risk factors that cannot be easily discerned by measured consumption volatility. The model with habits stands in contrast to that. Thus, like the Mehra and Prescott (1985) benchmark, it needs to rely on the historically low consumption growth rate to account for the low interest rates. However, for any

choice of γ , the habit model also puts a greater weight on the variance of consumption growth σ_c (since $\bar{S} < 1$), which was also low by historical standards in the post-2009 period. Therefore, for any choice of γ , the habit model would imply that the risk-free rate should have fallen by less than what is implied by the Mehra and Prescott (1985) benchmark.

One significant advantage of the habit formation model over the Mehra and Prescott model is that it can also accommodate the historically high equity risk premium, since the reduction in consumption in the aftermath of the Great Recession would have meant that “surplus consumption” S_t would be particularly low, leading to increased risk aversion.

6. SUMMARY AND CONCLUSION

The large drop in interest rates following the 2008 recession has given rise to discussions about whether the reduction was mainly due to policy or whether policy was following as best it could the “natural” rate and, in the latter case, what the determinants of that reduction could be. While explanations focusing on market segmentation have gained prominence, asset-pricing models in frictionless environments might also be able to provide sensible explanations for that drop.

In the text above, I discussed, on top of the benchmark power utility of Mehra and Prescott (1985), three leading varieties of consumption-based asset-pricing models with special focus on the determinants of the risk-free rate: long-run risk, disaster risk, and habit formation. All variants suggest that interest rates ought to be a function of expected consumption growth. This implication is consistent with the fact that consumption growth was low by historical standards in the 2009–13 period. At the same time, within this period there was a reduction in the volatility of consumption growth, which could enhance the effect of the reduced growth rate.

The challenge for the benchmark Mehra and Prescott (1985) framework is that this period also exhibits an equity premium that is high by historical standards, but consumption volatility is small. The three variants discussed are able to resolve that tension in different ways. Under long-run risk and disaster-risk models, agents’ risk perception would increase because of, respectively, higher variance in the long-run component of consumption growth or a perceived increase in the probability of a large consumption decrease. The former is consistent with historically high equity market volatility, and the latter with an upward revision of the probability of disaster following the Great Recession. Under the habit-formation model, the tension can potentially be resolved by the observation that the reduction in consumption

following the Great Recession led to increased risk aversion as households found themselves closer to their “subsistence” level of consumption. The explanations based on increased risk diverge from the habit formation in that the same increase in perceived risk that leads to an increased equity risk premium can also be an added factor explaining the reduced interest rate. In contrast, in the benchmark calibration adopted by Campbell and Cochrane (1995) for the habit-formation model, the presence of habits have no direct impact on how interest rates change over time but could reinforce the dampening effects of reduced one-step-ahead consumption volatility.

A priori, there is no reason why the different models cannot be combined. In particular, Nakamura et al. (2010) investigate asset-pricing implications of disasters that take multiple quarters to unfold when households have EZW preferences. Such disasters can be viewed as an intermediate case between the one-off disaster risk in Barro (2006) and the consumption growth rate uncertainty in Bansal and Yaron (2004). It is unclear whether extending a habit-formation model to allow for disaster risk would yield any additional insight. Combining habit formation with long-run risk would present a challenge since it would involve combining two forms of nonseparability in preferences.

APPENDIX: EULER EQUATION UNDER EZW PREFERENCES

The Euler equation under EZW preferences is obtained from the first-order conditions of the household subject to the budget constraint:

$$C_t + \sum_{i=1}^N P_{i,t} x_{i,t} = \sum_{i=1}^N x_{i,t-1} (P_{i,t} + D_{i,t}).$$

To derive the Euler equation under EZW preferences, we define household wealth as

$$W_{t+1} \equiv \sum_{i=1}^N x_{i,t-1} (P_{i,t} + D_{i,t}) = \sum_{i=1}^N x_{i,t-1} P_{i,t-1} R_{i,t}.$$

Given that definition, we can rewrite the budget constraint as

$$C_t + \sum_{i=1}^N P_{i,t} x_{i,t} = W_t.$$

Given that restated budget constraint, start with the “guess” that we can express the utility function as a linear function of wealth:

$$U_t = A_t W_t,$$

for some A_t to be determined. Note that A_t is time-varying, reflecting the fact that, if returns are not i.i.d., the utility of the household will vary as a function of the state of the economy. This is a reasonable guess since realized wealth is the only state variable in the household’s problem and the utility function is homogeneous of degree 1 in U_t and C_t . Given that redefinition and that “guess,” the household’s problem becomes

$$\begin{aligned} & A_t W_t \\ &= \max_{W_{t+1}, C_t, \{x_{i,t}\}_{i=1}^I} \left\{ \begin{aligned} & (1 - \beta) [C_t]^{1 - \frac{1}{\psi}} \\ & + \beta \left[\left(E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1 - \frac{1}{\psi}} \end{aligned} \right\}^{\frac{1}{1 - \frac{1}{\psi}}}, \\ \text{s.t. : } & C_t + \sum P_{i,t} x_{i,t} = W_t \\ & W_{t+1} = \sum_{i=1}^N P_{i,t} x_{i,t} R_{i,t+1}. \end{aligned}$$

The first-order conditions are

$$\begin{aligned} \text{for } W_{t+1} : & \omega_{t+1} = \beta U_t^{\frac{1}{\psi}} \left(E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right] \right)^{\frac{1 - \frac{1}{\psi}}{1-\gamma} - 1} A_{t+1}^{1-\gamma} (W_{t+1})^{-\gamma} \\ \text{for } C_t : & \lambda_t = (1 - \beta) U_t^{\frac{1}{\psi}} C_t^{-\frac{1}{\psi}} \\ \text{for } x_{i,t} : & \lambda_t = E_t [\omega_{t+1} R_{i,t+1}]. \end{aligned}$$

Note that there are in fact multiple first-order conditions for W_{t+1} since W_{t+1} will vary as a function of the ex-post realized state. There are accordingly multiple ω_{t+1} . The pricing kernel is given by

$$\frac{\omega_{t+1}}{\lambda_t} = \frac{\beta \left(E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right] \right)^{\frac{1 - \frac{1}{\psi}}{1-\gamma} - 1} A_{t+1}^{1-\gamma} (W_{t+1})^{-\gamma}}{(1 - \beta) C_t^{-\frac{1}{\psi}}},$$

which can be rearranged as

$$\frac{\omega_{t+1}}{\lambda_t} = \left(\frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{1-\gamma}} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}-1} \frac{\beta A_{t+1}^{1-\frac{1}{\psi}} (W_{t+1})^{-\frac{1}{\psi}}}{(1-\beta) C_t^{-\frac{1}{\psi}}}.$$

Given the guess for the functional form of U_t , the envelope condition is

$$A_t = \lambda_t = (1-\beta) U_t^{\frac{1}{\psi}} C_t^{-\frac{1}{\psi}}.$$

Substituting into the first-order condition for C_t and using the guess that $U_t = A_t W_t$, we can write the envelope condition as

$$A_t = (1-\beta) A_t^{\frac{1}{\psi}} W_t^{\frac{1}{\psi}} C_t^{-\frac{1}{\psi}}.$$

So that, rearranging

$$A_t^{1-\frac{1}{\psi}} = (1-\beta) \left(\frac{W_t}{C_t} \right)^{\frac{1}{\psi}}.$$

Lead this expression one period and use substitute out A_{t+1} from the second term in the pricing kernel:

$$\frac{\omega_{t+1}}{\lambda_t} = \left(\frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{1-\gamma}} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}-1} \frac{\beta (1-\beta) \left(\frac{W_{t+1}}{C_{t+1}} \right)^{\frac{1}{\psi}} (W_{t+1})^{-\frac{1}{\psi}}}{(1-\beta) C_t^{-\frac{1}{\psi}}}.$$

The expression then simplifies to

$$\frac{\omega_{t+1}}{\lambda_t} = \beta \left(\frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{1-\gamma}} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}-1} \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}}.$$

We can obtain the policy function for consumption by rearranging the envelope condition to obtain

$$C_t = (1-\beta)^\psi A_t^{1-\psi} W_t \equiv \mu_t W_t,$$

so that consumption is linear in wealth.

To obtain an expression for next-period wealth as a function of current wealth, we can write the second constraint alternatively as

$$W_{t+1} = R_{w,t+1} \times \sum_{i=1}^N P_{i,t} x_{i,t},$$

where $R_{w,t+1} \equiv \sum_{i=1}^N \frac{P_{i,t} x_{i,t}}{\sum_{i=1}^N P_{i,t} x_{i,t}} R_{i,t}$ is the return on total wealth. Since, in equilibrium, $x_{i,t}$ equals the supply of different assets i , $R_{w,t+1}$ can be taken as exogenous to the household's problem. With this change in notation, we can combine the two constraints on the household's problem to obtain

$$W_{t+1} = R_{w,t+1} (W_t - C_t) \equiv R_{w,t+1} (1 - \mu_t) W_t.$$

Finally, one can use the envelope condition to write A_t as a function of μ_t :

$$A_t^{1-\frac{1}{\psi}} = (1 - \beta) \mu_t^{-\frac{1}{\psi}}.$$

With these two expressions, we can verify the "guess" that utility is linear in wealth. Substitute them into the utility function to obtain

$$A_t W_t = \left\{ \begin{array}{l} (1 - \beta) [\mu_t]^{1-\frac{1}{\psi}} \\ + \beta \left[\left(E_t \left[(A_{t+1} R_{w,t+1} (1 - \mu_t))^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1-\frac{1}{\psi}} \end{array} \right\}^{\frac{1}{1-\frac{1}{\psi}}} W_t.$$

We can then cancel out W_t from both sides, to obtain an expression relating A_t and μ_t :

$$A_t = \left\{ \begin{array}{l} (1 - \beta) [\mu_t]^{1-\frac{1}{\psi}} \\ + \beta \left[\left(E_t \left[(A_{t+1} R_{w,t+1} (1 - \mu_t))^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1-\frac{1}{\psi}} \end{array} \right\}^{\frac{1}{1-\frac{1}{\psi}}}.$$

Rearranging,

$$A_t^{1-\frac{1}{\psi}} = (1 - \beta) [\mu_t]^{1-\frac{1}{\psi}} + \beta \left[\left(E_t \left[(A_{t+1} R_{w,t+1})^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1-\frac{1}{\psi}} (1 - \mu_t)^{1-\frac{1}{\psi}}.$$

Substituting in $A_t^{1-\frac{1}{\psi}} = (1 - \beta) \mu_t^{-\frac{1}{\psi}}$,

$$(1 - \beta) \mu_t^{-\frac{1}{\psi}} = (1 - \beta) [\mu_t]^{1 - \frac{1}{\psi}} + \beta \left[\left(E_t \left[(A_{t+1} R_{w,t+1})^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1 - \frac{1}{\psi}} (1 - \mu_t)^{1 - \frac{1}{\psi}}.$$

Now substitute in the expression for growth in wealth as a function of returns, $W_{t+1} = R_{w,t+1} (1 - \mu_t) W_t$,

$$\begin{aligned} & (1 - \beta) [\mu_t]^{-\frac{1}{\psi}} \\ = & (1 - \beta) [\mu_t]^{1 - \frac{1}{\psi}} \\ & + \beta \left[\left(E_t \left[\left(\frac{A_{t+1} W_{t+1}}{(1 - \mu_t) W_t} \right)^{(1-\gamma)} \right] \right)^{\frac{1}{1-\gamma}} \right]^{1 - \frac{1}{\psi}} (1 - \mu_t)^{1 - \frac{1}{\psi}}, \end{aligned}$$

so that, rearranging

$$\frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{(1-\gamma)}} = \left[(1 - \beta) \beta^{-1} \left(\frac{1 - \mu_t}{\mu_t} \right)^{\frac{1}{\psi}} \right]^{\frac{1-\gamma}{1 - \frac{1}{\psi}}} \left(\frac{(1 - \mu_t) W_t}{A_{t+1} W_{t+1}} \right)^{1-\gamma}.$$

Note that

$$W_{t+1} = R_{w,t+1} (1 - \mu_t) W_t,$$

so that

$$\frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{(1-\gamma)}} = \left[(1 - \beta) \beta^{-1} \left(\frac{1 - \mu_t}{\mu_t} \right)^{\frac{1}{\psi}} \right]^{\frac{1-\gamma}{1 - \frac{1}{\psi}}} \left(\frac{1}{A_{t+1} R_{w,t+1}} \right)^{1-\gamma}.$$

Also,

$$\frac{C_{t+1}}{\mu_{t+1}} = R_{w,t+1} \frac{1 - \mu_t}{\mu_t} C_t,$$

so that

$$\begin{aligned} & \frac{E_t \left[(A_{t+1} W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1} W_{t+1})^{(1-\gamma)}} \\ = & \left[(1 - \beta) \beta^{-1} \left(\frac{1}{\mu_{t+1} R_{w,t+1}} \frac{C_{t+1}}{C_t} \right)^{\frac{1}{\psi}} \right]^{\frac{1-\gamma}{1 - \frac{1}{\psi}}} \left(\frac{1}{A_{t+1} R_{w,t+1}} \right)^{1-\gamma}. \end{aligned}$$

Finally, since $A_{t+1}^{1-\frac{1}{\psi}} = (1-\beta)\mu_{t+1}^{-\frac{1}{\psi}}$,

$$\begin{aligned} & \frac{E_t \left[(A_{t+1}W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1}W_{t+1})^{(1-\gamma)}} \\ &= \left[(1-\beta)\beta^{-1} \left(\frac{1}{\mu_{t+1}R_{w,t+1}} \frac{C_{t+1}}{C_t} \right)^{\frac{1}{\psi}} \right]^{\frac{1-\gamma}{1-\frac{1}{\psi}}} \left(\frac{1}{(1-\beta)^{\frac{1}{1-\frac{1}{\psi}}} \mu_{t+1}^{-\frac{1}{\psi} \frac{1}{1-\frac{1}{\psi}}} R_{w,t+1}} \right)^{1-\gamma}. \end{aligned}$$

Note that μ_{t+1} cancels out. Collecting terms,

$$\frac{E_t \left[(A_{t+1}W_{t+1})^{(1-\gamma)} \right]}{(A_{t+1}W_{t+1})^{(1-\gamma)}} = \left[\beta^{-1} \left(\frac{C_{t+1}}{C_t} \right)^{\frac{1}{\psi}} R_{w,t+1}^{-1} \right]^{\frac{1-\gamma}{1-\frac{1}{\psi}}}.$$

Substitute back in the expression for the pricing kernel to obtain

$$\frac{\omega_{t+1}}{\lambda_t} = \beta \left(\left[\beta^{-1} \left(\frac{C_{t+1}}{C_t} \right)^{\frac{1}{\psi}} R_{w,t+1}^{-1} \right]^{\frac{1-\gamma}{1-\frac{1}{\psi}}} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}-1} \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}}.$$

Rearranging,

$$\frac{\omega_{t+1}}{\lambda_t} = \left[\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}} \right]^{\frac{1-\gamma}{1-\frac{1}{\psi}}} R_{w,t+1}^{\frac{1-\gamma}{1-\frac{1}{\psi}}-1},$$

which, given $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$, corresponds to the pricing kernel in equation (10).

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Should Greece Remain in the Eurozone?

Robert L. Hetzel

Understanding the way forward for Greece requires understanding the cause of its prolonged depression. The argument popular in Greece’s creditor countries is that the depression results from prior fiscal profligacy leading to the collapse of an unsustainable debt burden. The argument popular in Greece is that depression results from fiscal austerity forced on it by its external creditors.¹ These arguments are unsatisfactory and offer little useful guidance for the way forward. An excessive level of debt and the need for fiscal austerity are symptoms or fallout from the underlying root problem. In order to eliminate an unsustainable current account deficit, Greece must undergo depreciation in its internal terms of trade relative to its Eurozone partners. Because Greece is in a currency union with near price stability, I argue that depreciation must occur through Greece having a lower inflation rate than the rest of Europe, which likely means Greece having deflation. The economic disruption from the required deflation has forced austerity on Greece as a consequence of the accompanying deterioration in its fiscal condition. Austerity assures investors of the

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¹ A comment in a *Wall Street Journal* (2015a, A8) article summarized these alternative views. “The populist rhetoric of many Greek politicians blames the country’s economic depression on the terms of the bailout since 2010, rather than on Greece’s lack of fiscal discipline in the years up to 2009.” Measuring the impact of fiscal policy and budget deficits is perennially contentious because of the issue of endogeneity. The fact that deficits increase in recession obscures their possible stimulative impact. As a condition for joining the Eurozone, however, Greece reduced its deficit from 13.2 percent of GDP in 1994 to 3 percent in 1999 without any noticeable impact on real output growth (Herz and Kotios [2000] and Federal Reserve Bank of St. Louis FRED database).

long-term solvency of the government, which is necessary in order to avoid capital flight and the resulting collapse of the banking system.

Is there any way to avoid the root problem of required deflation?² If Greece had never joined the Eurozone but had retained the drachma as its currency, the required depreciation in its terms of trade would have occurred through the depreciation in its currency. Exports would become cheaper to foreigners and imports dearer to Greeks as the drachma price of foreign currencies increased. Lacking that mechanism, the only alternative is for the Greek price level to fall relative to the price level of its Eurozone partners. Deflation uncoordinated by a common set of expectations, however, disrupts the price system and the real economy. Moreover, it causes bankruptcies by raising the ratio of euro-denominated debts relative to the income of debtors.

Unfortunately, a return to the drachma is no longer feasible. Greece is “euroized” now in the way that Panama is “dollarized.” The euro offers a secure store of value. Even if Greece adopted the drachma and made it the only legal tender, a newly resurrected drachma would likely depreciate in value overnight. Greeks might reasonably think, “Why would the government issue it if not to print large quantities in order to finance deficits?” [The] resulting drachma hyperinflation would leave the euro as the only acceptable currency.

Until 2012, Greece accumulated external debt by running a current account deficit. Starting in 2010, it also accumulated external debt from official assistance programs. Now, it must run current account surpluses in order to pay off that debt. For that to happen, it must deflate. Greece has two choices, both painful. One choice is that the Greek government commits to implementation of the reforms required by a third bailout program. Over time, confidence in a stable political environment revives foreign investment in Greece. Foreign capital inflows offset the capital outflows required in order to pay off debt. Greece can thus limit the required internal deflation and economic disruption.

The choice with catastrophic consequences is a lack of persistent commitment to market reforms accompanied by political instability. In 2015, Greece’s creditors credibly threatened Grexit (Greek exit from the Eurozone) and collapse of the Greek banking system as an outcome.

² In the spirit of this article, Charles Calomiris has proposed a government-mandated reduction in Greek prices: “My proposal begins with government action to write down the value of all euro-denominated contracts enforced within Greece. This ‘redenomination’ would make all existing contracts—wages, pensions, deposits, and loans—legally worth only, say, 70% of their current nominal value.”

The assumption here is that the proposal is impractical because it assumes a pervasive degree of governmental control and enforcement that does not exist in Greece. It would also apply unevenly. Government and unionized workers with contracts would incur a wage decline but workers with informal contracts would not.

If Grexit reemerges as a possibility and again sets off deposit flight from Greek banks and capital flight from Greece, a collapse in the Greek financial system and economy risks returning Greece to the kind of economic prostration experienced after World War II.

Section 1 reviews the economics of a balance-of-payments equilibrium within a currency union like the Eurozone. As institutional background, it explains the role of the system for clearing payments among countries in the Eurozone known as TARGET2. It also elaborates on the two alternatives for making fiscal transfers within the Eurozone, that is, either through explicit aid from governments or from the allocation of the seigniorage revenues of the European Central Bank (ECB). Section 2 summarizes the capital flight crisis in the Eurozone in 2011 and 2012. Sections 3, 4, and 5 provide a history of the Greek current account deficits and explore the economics of how Greece can repay its debts. Section 6 reviews the German experience since the start of the euro and asks whether Germany should serve as a model for Greece. The remaining sections explain the difficulties that Greece will have to confront in achieving sustainable balance-of-payments equilibria, discuss Greece's future options, and offer a concluding note.

1. BALANCE-OF-PAYMENTS ADJUSTMENT WITHIN REGIONS OF A CURRENCY UNION

For ease of exposition of balance-of-payments adjustment within a currency union, consider Greece as standing in for an individual country and Germany as standing in for the rest of the Eurozone. Greece's trade account is the difference between the euros earned from the export of its goods and services and the euros paid for the import of goods and services. The current account adds income earned on Greek investments abroad minus income paid to foreigners on their investments in Greece. There is also an adjustment made for net unilateral transfers like foreign aid.

The financial account is the mirror image of the current account. If Greece runs a current account deficit, then Germans are accumulating debt (IOUs) from Greeks. Equivalently, a current account deficit must be matched by a capital inflow in which Greeks sell assets to Germans. If Greece imports more goods from Germany than it exports to Germany, it must pay the difference, that is, have a capital inflow (export IOUs). That capital inflow could be in the form of additional foreign ownership of Greek bonds, equity, or land. To summarize, a current

account deficit implies an offsetting capital inflow and a current account surplus implies an offsetting capital outflow.³

Assume that Greece and Germany had their own currencies and that the Greek drachma and the German mark floated freely against each other. Assume also a sudden stop in inflows of private capital that had been financing a Greek current account deficit. In this event, the drachma would depreciate relative to the mark in order to maintain balance-of-payments equilibrium. Greece's terms of trade would depreciate in that its goods would become less expensive relative to German goods. However, with a currency union, settlement is in the single currency, the euro. The accounting identity between the current and the capital account of course still holds. If, say, a Greek current account deficit exceeds the private capital inflow from Germany, then the difference is made up for by a transfer of bank reserves from Greece to Germany. Bank reserves decline in Greece and increase in Germany.

In a world without monetary frictions, the associated decline in the money stock in Greece would cause a decline in the Greek price level (deflation) while the increase in the money stock in Germany would cause an increase in the German price level (inflation). The depreciation in the Greek terms of trade arises from this change in relative price levels. In reality, the required deflation in Greece takes time. As a result, when capital inflows precipitately become capital outflows and money contracts ("sudden stops"), the required sudden balance between imports and exports occurs through recession that restricts the demand for imports.

In order to understand better the working of sudden stops in capital inflows in the context of the Eurozone, it is helpful to understand some institutional details. First, it is useful to note the way in which the members of the Eurozone clear payments among themselves using the TARGET2 system.⁴ It is a payments clearing system that records net flows of bank reserves among Eurozone member countries. Second, the ECB allows banks to borrow for extended periods. As a result, when the banks in Greece lose reserves, they can replace them by borrowing from the ECB through their national central bank, the Bank of Greece. That is, the national central bank creates new reserves to replace the reserves lost to German banks.

³ The financial account records transactions for direct investment, portfolio investment, and other investment, which includes bank deposits and reserves. The discussion ignores the capital account, which is typically small. It records capital transfers such as debt forgiveness.

⁴ TARGET2 is the abbreviation for the Trans-European Automated Real-time Gross Settlement Express Transfer system 2. It is the large-value cross-border payments and settlement system for the Eurozone.

In the context of a Greek balance-of-payments deficit relative to Germany not financed by capital inflows (official or private), this borrowing from the ECB creates the reserves to pay for the excess of imports. On the ECB's balance sheet, this reserve creation appears as loans to Greek banks. For the Greek central bank, it appears as a liability to the TARGET2 system. At the same time, however, Greek banks feel regulatory and market pressure to contract their balance sheets in order to repay the ECB loans. As a consequence, they contract loans and deposits. Greek nationals lose deposits while German nationals gain deposits. Over time, this redistribution of deposits causes the changes in relative national price levels that eliminate the Greek current account deficit and turn it into a surplus. Greek banks can then repay the loans from the ECB registered in the TARGET2 system.

The Eurozone has two broad mechanisms for making the fiscal transfers required in order to lessen the harsh adjustments imposed by the sudden reversal of capital inflows to capital outflows. The first is direct aid. Direct aid has included the Eurozone's European Financial Stability Facility (EFSF), which was replaced by the European Stability Mechanism. The second mechanism is the one described above, which makes use of the seigniorage power of the ECB. Although the borrowing by Greek banks from the ECB buffers the transition from a current account deficit to current account balance (or surplus) required by sudden stops in capital inflows, it is controversial because it constitutes unlegislated fiscal policy.

Central banks earn revenue from money creation (seigniorage) because their assets earn interest in excess of their liabilities such as currency. The ECB distributes the excess of its revenues over its own expenses to its member countries based on their capital contributions. The ECB can effectively allocate some of its seigniorage revenue to the banks of particular countries by lending reserves to them at rates below which they could borrow in the market. Loans to banks occur through various programs.

Under the MRO (main refinancing operations) program, banks borrow reserves by entering into repurchase agreements with the ECB based on high quality collateral. The LTRO (long-term refinancing operations) program, which was followed by a smaller targeted long-term refinancing operations program, offered multiyear loans. The ELA (emergency liquidity assistance) program offers loans at a higher rate than the MRO but with inferior quality collateral. In addition, in spring 2010 and summer 2011, the ECB bought the debt of countries directly through the SMP (securities markets program). The possibility also exists of purchases of sovereign debt as part of the outright monetary transactions program, which replaced the SMP.

2. THE CAPITAL FLIGHT CRISIS

From its start in 1998 through 2008, cross-border financial holdings in the Eurozone increased from about 200 percent of GDP to 600 percent (Pisani-Ferry, Sapier, and Wolff 2013, Figure 20). The purchase of debt rather than equity investment dominated the capital flows. However, the Eurozone experienced two recessions with business cycle peaks occurring in 2008:Q1 and 2011:Q1.⁵ When recovery from the first recession collapsed, financial markets became concerned about the survival of the Eurozone. From mid-summer 2011 to mid-summer 2012, investors fled the sovereign debt markets of the peripheral countries.⁶ Fears for the survival of the euro concentrated on Italy and Spain because they were too big to fail and too big to bail out. Italy's debt/GDP ratio was 120 percent and Spain needed a recapitalization of its banking system. The willingness of the core countries, especially Germany, to backstop the issuance of Eurobonds to bail out a country as large as Italy or Spain was uncertain.

The fear of a self-reinforcing feedback loop between a sovereign debt crisis and a banking crisis emerged. The possibility of sovereign default meant that the country's banks, which held large amounts of their government's debt, could become insolvent. That possibility created an incentive for the foreign depositors of the banks in the peripheral countries to withdraw their funds and redeposit them in core-country banks and for core-country banks to sell the debt of the peripheral countries. In this way, the depositors and banks making the funds transfers protected themselves against "redenomination risk," that is, the risk that a peripheral country would leave the Eurozone and redenominate its bank deposits in a new, depreciated national currency. However, that capital flight exacerbated the government's fiscal difficulties by weakening the banks and the economies of the peripheral countries and thus increased sovereign default risk, and so on. "Between mid-2010 and end-2011, foreign investors cumulatively reduced their exposure to high-spread euro area sovereign debt by about US\$ 400 billion" (Arslanap and Tsuda 2012, 26).

Capital flight from the peripheral countries intensified in line with talk of debt restructuring (write-downs or haircuts). In October 2010,

⁵ Hetzel (2013) argued that contractionary monetary policy caused the recessions. Both in 2008 and again in 2010, a commodity-price inflation shock pushed headline inflation far above core inflation, which remained near 2 percent. In each case, the ECB raised interest rates and maintained them at a level that caused aggregate nominal demand to fall. Real demand and output had to fall in order to keep headline inflation at or below 2 percent. Hetzel (2012) extended the argument to the United States.

⁶ The peripheral countries are Portugal, Italy, Ireland, Greece, and Spain. The principal core countries are Germany, France, the Netherlands, and Austria.

in Deauville, France, German Chancellor Angela Merkel and French President Nicolas Sarkozy agreed that in the future government debt securities would include collective action clauses, which would facilitate restructuring. The principle of debt write-downs became known as private sector involvement (PSI). “[I]n July 2011, debt restructuring was officially endorsed [by the European Union Council] as an option for Greece....But agreement on a deep PSI had to wait until October 2011, and negotiations were only completed in February 2012” prior to the Second Economic Adjustment Program announced in March 2012 (Pisani-Ferry, Sapier, and Wolff 2013, 42, 68).⁷ By early 2012, holders of Greek debt, chiefly French and German banks, had either sold or allowed the debt to run off. As a consequence, 80 percent of Greek debt passed into the hands of foreign official institutions (the EFSF, the ECB, and the International Monetary Fund [IMF]) with much of the remainder held by Greek banks (Slok 2015).

The decision not to require Eurozone banks to write off their Greek debt but rather to convert it into debt held by official creditors was controversial in that it kept the Greek debt-to-GDP ratio at an extremely high level. At the time, the Euro area ruled out debt restructuring. The required approval of Eurozone parliaments would have been unlikely (International Monetary Fund 2013b, 27). From 2001 to 2009, Greek government debt held externally by the private sector went from about €80 billion to about €225 billion. By 2012, it had declined to less than €50 billion. On the flip side, between 2009 and 2012, Greek government debt held by official creditors went from zero to about €225 billion (International Monetary Fund 2013b, 18).

Cecchetti, McCauley, and McGuire (2012) noted that the part of a current account deficit not financed by private capital inflows or official aid would register in the form of a TARGET2 imbalance. (TARGET2 imbalances in turn measure the key variable—bank borrowing from the ECB.) They provided the following taxonomy of the capital-flight crisis of the peripheral countries. From 2002 to mid-2007, private capital inflows completely financed current account deficits. From mid-2007 through 2009, private capital flows financed three-fifths of their current account deficits. From 2010 through 2011, as reflected in TARGET2 imbalances, borrowing from the ECB by banks in the peripheral countries financed all of current account deficits. However, in 2012:Q1 and 2012:Q2, the growth of TARGET2 imbalances far outpaced the

⁷ Gulati, Trebesch, and Zettlmeyer (2012, Abstract) put the aggregate haircut on privately outstanding Greek debt at 55 percent–65 percent depending upon the valuation of the old bonds and estimated the debt relief received by Greece to be on the order of 48 percent of GDP.

current account deficits. As Cecchetti, McCauley, and McGuire noted, their growth corresponded to capital flight, that is, the transfer of deposits from the banks of peripheral countries to those of core countries, especially to German banks.⁸

Using current account and TARGET2 data, Vihriälä (2013) concluded:

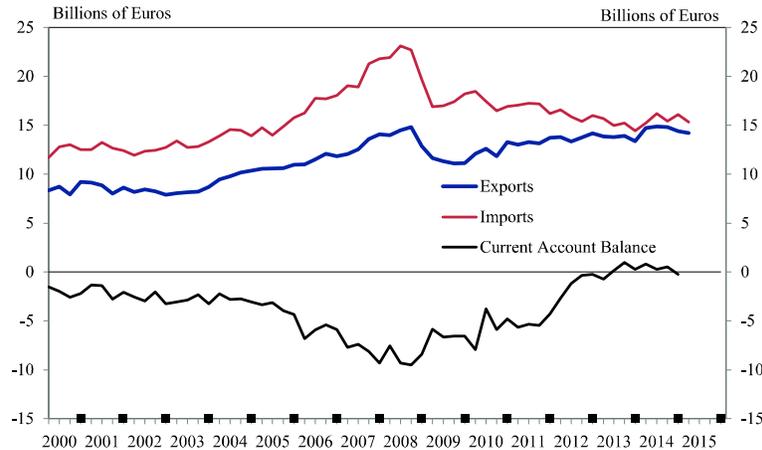
Between April 2010 and August 2012, net private capital outflows totaled 167bn [euros] in Greece, 118bn in Ireland and 99bn in Portugal. In terms of pre-crisis GDP, these figures amount to about 75%, 62% and 59% respectively. Starting in summer 2011, private investors started to leave also Italy and Spain, which between May 2011 and August 2012 recorded outflows of 303bn (19% of pre-crisis GDP) and 364bn (35% of pre-crisis GDP)...Before the announcement [ECB President Mario Draghi's pledge to do "whatever it takes" to preserve the monetary union] a larger and larger share of Greek, Irish, Italian and Spanish bonds had been off-loaded by foreign investors and acquired by domestic banks. . . .

The ECB contributed significantly to the fiscal transfers required to offset capital flight from the peripheral countries of the Eurozone. That fact appears in the increase in the size of the ECB's balance sheet. Measured relative to Eurozone GDP, in fall 2008, it went from about 15 percent to 20 percent. In spring 2011, it began to increase again, reaching somewhat more than 30 percent by early 2013. The expansion in the ECB's balance sheet appeared in the diminution of the importance attached to its traditional means of supplying reserves to banks through the short-term auction of funds, the MROs. In their place, the ECB began supplying reserves through LTROs, which redirected lending toward banks in the periphery.

3. GREEK BALANCE-OF-PAYMENTS ADJUSTMENT

The underlying premise here is that the capital inflows and current account deficit that accompanied Greek membership in the Eurozone in 2001 caused its real terms of trade to appreciate through an inflation rate in excess of the Eurozone average. The capital flight that began

⁸ In the case of Greece, over the period from mid-2011 to mid-2012, the increase in borrowing from the Bank of Greece exceeded the increase in TARGET2 liabilities by about €30 billion. The difference reflected the extent of an internal currency drain, that is, withdrawals of cash held under mattresses. However, if a Greek bank borrows from the Bank of Greece in order to replace reserves lost due to a wire transfer by a depositor at a Greek bank to the account of a bank in Frankfurt, then TARGET2 liabilities increase.

Figure 1 Greece: Imports and Exports of Goods and Services

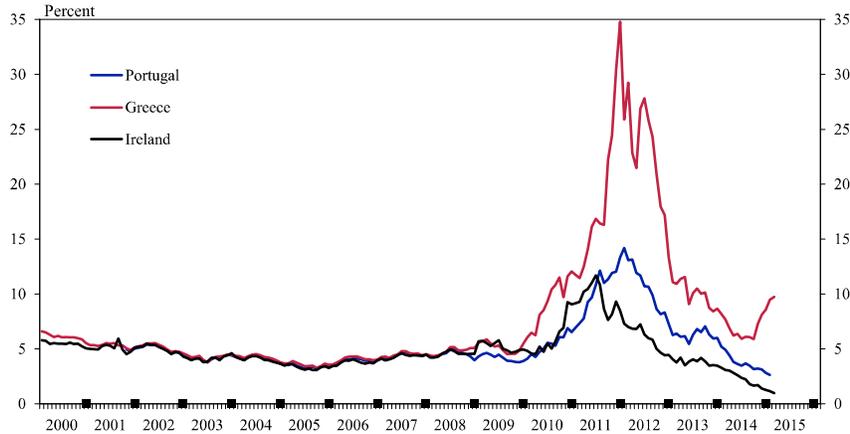
Notes: Data are quarterly averages. Heavy tick marks indicate the fourth quarter of year.

Source: Haver Analytics.

at the end of 2009 reversed this process and has forced deflation and prolonged depression on the Greek economy.

Greek membership in the Eurozone made it an attractive place to invest. The other side of the resulting capital inflows was a current account deficit. For Greece, Figure 1 shows exports, imports, and the current account balance. In fall 2008, private capital inflows ceased because of the recession and financial crisis. Banks in the rest of the Eurozone ceased accumulating loans to Greek banks and Greek government debt. As shown in Figure 2, the yield on Greek 10-year bonds did not increase significantly until November 2009. The earlier cessation in additions to Greek debt thus likely reflected the general increase in bank home bias produced by the financial crisis rather than capital flight (Arslanap and Tsuda 2012, 32).

In the October 2009 elections, PASOK replaced New Democracy as the governing party in Greece. A restatement of government

Figure 2 Yields on 10-Year Government Bonds

Notes: Heavy tick marks indicate December.

Source: ECB and Haver Analytics.

finances revealed a large government deficit, currently estimated at 9.5 percent of GDP for 2008 (Federal Reserve Bank of St. Louis FRED database). “Sentiment deteriorated further in November [2009] when the estimated 2009 fiscal deficit was revised from $13 \frac{1}{2}$ to $15 \frac{1}{2}$ percent of GDP, and in December there were general strikes and rioting in response to the labor reforms” (International Monetary Fund 2013b, 35). Concerns then arose over the sustainability of the Greek budget deficit and the solvency of Greek banks, which held considerable amounts of Greek government debt. In 2010, foreign investors began selling Greek government debt and the cessation of capital inflows turned into outright capital outflows. In 2011, private capital flight worsened as part of the general sovereign debt crisis affecting the peripheral countries of the Eurozone.⁹

⁹ Eurozone banks’ loans to Greece reached about €128 billion in 2008 and fell to about €12 billion in September 2013 (Merler 2015).

In March 2010, the European Commission, the ECB, and the IMF formed the Troika in order to coordinate lending to Greece based on “conditionality.”¹⁰ Starting with bilateral loans to Greece in April 2010 from member countries of the Eurozone, the Eurozone has provided considerable direct aid to Greece. The Eurozone created the EFSF to coordinate Eurozone government aid. Fear of a Greek exit from the Eurozone grew starting in the last half of 2011 and reached its peak intensity in the first half of 2012.¹¹ Considerable doubt existed as to whether Greece would implement the terms of the February 2012 Second Economic Adjustment Program, which had replaced the original adjustment program of May 2010. The June 17, 2012, parliamentary elections resulted in a coalition government formed by Prime Minister Antonis Samaras, who made clear that Greece would accept the Troika adjustment program. In November 2012, the Greek Parliament approved the austerity package.

The ECB is the residual lender financing the Greek payments imbalance (current account deficit plus net capital flows) not covered by the other Troika members. In the first instance, when Greeks import more than they export or capital flows out of the country, Greek banks lose reserves. They replace those reserves by borrowing from the ECB in one of the ways described above. From a negligible amount prior to mid-2008 to mid-2011, the share of Greek banks in total MRO and LTRO financing from the ECB rose to 20 percent (Pisani-Ferry, Sapier, and Wolff 2013, Figure 2). In summer 2011, Greek banks turned to the ELA facility (Milligan 2012). ELA borrowing from the Bank of Greece rose to €120 billion by summer 2012 (Pisani-Ferry, Sapier, and Wolff 2013, Figure 3). By early 2012, the Bank of Greece funded about 30 percent of the liabilities of Greek banks (European Central Bank 2015).

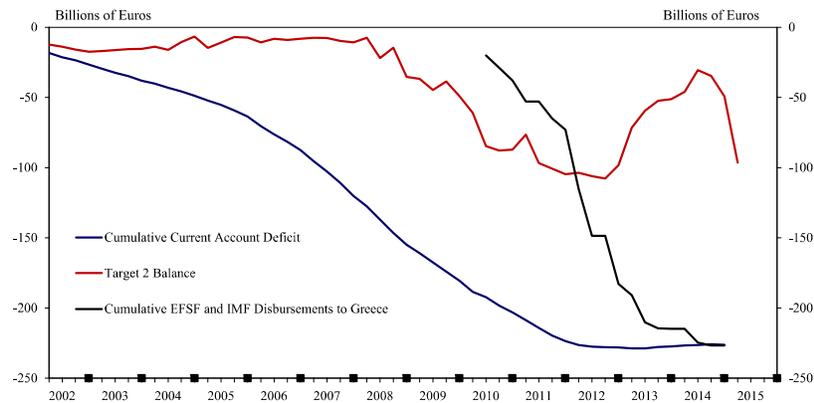
Figure 3 offers insight into how Greece has financed its current account deficit and dealt with capital flight. The cumulative current account deficit measures the amount of debt that Greece owes the rest of the world as a consequence of past trade deficits.¹² That debt can be held by private investors who voluntarily invest in Greece, by the ECB in the form of lending to Greek banks and in the form of Greek

¹⁰ The European Commission acts on behalf of the member states whose governments must approve the disbursement of funds from the EFSF.

¹¹ “As 2011 progressed, a Greek euro exit became a serious possibility particularly after being discussed by Euro leaders at the Cannes summit in November 2011. The government then announced a referendum to test the views of the Greek people. This was subsequently cancelled but the government resigned later that month and was replaced by a technocratic government” (International Monetary Fund 2013b, 35).

¹² It is roughly equal to the net international investment position, which includes changes in asset valuations of assets held in Greece by foreigners and by Greeks abroad.

Figure 3 Greece: Sources of Financing the Current Account Deficit



Notes: Heavy tick marks indicate fourth quarter of year.

Source: EuroStat, Haver Analytics, and European Commission (April and August 2014).

government debt held outright, and by foreign official institutions (the IMF and Eurozone stabilization funds).¹³

As shown in Figure 1, Greece ran a current account deficit from 2000 through 2012 when the deficit approached zero. As a result, in Figure 3, the blue line showing the cumulative current account declined until end 2012.¹⁴ The fact that TARGET2 liabilities (shown by the red line) were essentially zero until 2008 implies that private capital inflows largely financed the current account deficit until then.¹⁵ After 2008, Greek TARGET2 liabilities mounted. Greece then financed its current

¹³ *The Wall Street Journal* (2015b) gave the following breakdown (in billions of euros) for early 2015: EFSF (131.0), Eurozone governments (52.9), private investors (34.1), ECB (26.9), IMF (21.1), and Treasury bill holders (14.8). The ECB figure does not include lending to Greek banks.

¹⁴ The line showing the cumulative current account deficit starts at € -45 billion, which is the cumulative current account deficit run from 1980 through 1999 (Eurostat/Haver).

¹⁵ Financial aid from the European Union for structural adjustment (not balance of payments aid) was also significant. As a percentage of Greek GDP, it averaged 2.5 percent from 2000 through 2007 (Bitros, Batavia, and Nandakumar 2014, Table 1). As

account deficit through spending down its bank reserves, which Greek banks replaced by borrowing from the ECB as indicated by the increase in TARGET2 liabilities. Starting in May 2010, Greece began to receive regular disbursements from external, official sources. In Figure 3, the black line measuring this aid mounts to nearly €225 billion. In 2010, 2011, and 2012, Greece financed its current account deficit and offset reserve outflows produced by capital flight through the combined aid of the official institutions and from ECB borrowing as registered by the increase in TARGET2 liabilities. Thereafter and continuing through 2014, as shown by the decline in TARGET2 liabilities, Greece used official aid to repay much of its ECB borrowing and some externally held private debt.

In January 2015, the uncertainty created by the replacement of the New Democracy government of Prime Minister Samaris with the Syriza government of Prime Minister Alexis Tsipras again produced capital flight and runs on banks. ELA borrowing by Greek banks rose while TARGET2 liabilities again increased (Figure 3). ECB funding of Greek banks (MRO, LTRO, and ELA lending) peaked at about €135 billion in summer 2012; fell to about €40 billion in late 2014; and then rose again to somewhat above €100 billion in February 2015 (Deutsche Bank 2015, 6). As of March 2015, Greek banks had liabilities of about €550 billion.¹⁶

4. THE GREEK TRANSFER PROBLEM

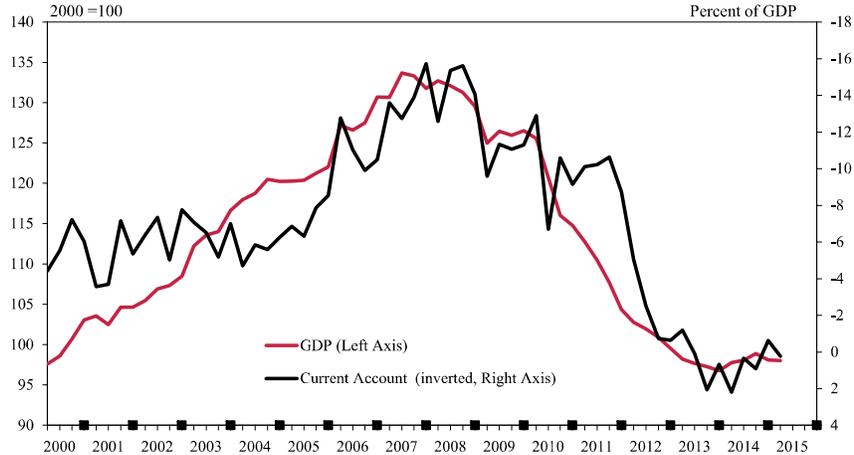
The repayment of the euro-denominated debt owed by Greece to its external creditors (the IMF, the ECB, the EFSF, and now chiefly hedge funds) requires a transfer of resources to foreigners.¹⁷ That is, Greece must run a balance of trade surplus. For that to happen, the Greek intra-Eurozone terms of trade must depreciate.¹⁸ There are two aspects to the required terms of trade depreciation.

a percentage of GDP, the Greek current account deficit averaged 6.7 percent from 2000 to 2005. The ratio deteriorated to 14.2 percent in 2007–08.

¹⁶ From Bank of Greece, “aggregated balance sheet of MFIs.” The ECB limits the ability of the four largest Greek banks to add to their net holdings of Greek Treasury bills. In doing so, it prevents the Greek government from financing deficits by issuing Treasury bills to the banks, which then use them as collateral to borrow from the ELA facility.

¹⁷ The term “transfer problem” came from a debate in the late 1920s between John Maynard Keynes and Bertil Ohlin over the feasibility of making the resource transfers implied by the reparations imposed upon Germany after World War I.

¹⁸ In principle, the euro could depreciate relative to currencies like the dollar sufficiently in order for Greece to run a balance of trade surplus (current account surplus) with the rest of the world large enough to offset a deficit with Eurozone countries. That possibility is unlikely and the analysis focuses exclusively on the Greek intra-Eurozone terms of trade.

Figure 4 Greece: Real GDP and Current Account

Notes: Current account measured as a percentage of real GDP. Real GDP indexed to 2,000=100. Heavy tick marks indicate fourth quarter of year.

Source: EuroStat and Haver Analytics.

First, the Greek terms of trade must depreciate to a level that assures a sustainable current account balance (given net capital flows from abroad). At present, current account balance has been achieved mainly due to a reduction in the demand for imports consequent upon a massive contraction in domestic demand. By 2015, Greek GDP had fallen 26 percent below its 2008 peak. Figure 4 shows the common decline in real GDP and the current account after 2008. Figure 1 shows that since 2008 exports have not increased while imports have declined.¹⁹ The Greek terms of trade must depreciate (the Greek price level must fall relative to the price level of its other Eurozone partners)

¹⁹ Half of Greek exports are services, which are dominated by shipping and tourism. The slowdown in world trade after 2008, something over which Greece has no control, hurt exports. Greek exports had been recovering steadily from the 2009 trough, but the renewed deposit outflows from Greek banks in the first half of 2015 is likely to limit the credit exporters need in order to finance exports.

in order to achieve current account balance (net of private capital flows from abroad) at full employment.

Second, there must be a one-time adjustment (overshooting) in the terms of trade depreciation that generates the current account surplus required in order to pay off the external debt.²⁰ Greece's Eurozone creditors have lengthened considerably the maturity of the debt owed by Greece. Even with Greece's present elevated debt-to-GDP ratio, Greece need only transfer about 2 percent of its GDP annually (Wolff 2015b). Equivalently, it need only run an annual current account surplus of that magnitude apart from net private capital flows.²¹ Although these numbers are not unusual for countries, they do add to the required terms-of-trade depreciation.

In a world in which price levels adjusted without friction, the Greek terms of trade would depreciate through a reduction in its domestic price level. According to the classical price-specie mechanism of David Hume, how would this occur?²² Consider the annual payment for an extended period of, say, €1 billion to external creditors. The Greek government would first run a budget surplus of €1 billion, which would increase its account with the Bank of Greece by that amount and reduce the deposits of Greek nationals by the same amount. It would then write a check, say, to the EFSF. When the EFSF cashes its check drawn on the Bank of Greece, the reserves of the Greek banking system decline. When the EFSF pays down its debt, the deposits of its bondholders increase. Because its bondholders are almost exclusively non-Greek nationals, the reserves end up outside of Greece.

Assuming that Greek banks cannot borrow from the ECB in order to make up the loss, they sell assets or call in loans in order to obtain reserves. As a result, Greek nationals experience a reduction in their euro deposits. (That reduction would not occur if the Greek government had used its budget surplus in order to make domestic purchases.) In order to bring their money holdings back to the desired level, Greek nationals reduce their expenditures. Greece needs to run an annual current account surplus (excess of exports over imports) of €1 billion in order to import the euros required to replenish the depleted cash balances of its nationals. Adjustment occurs when the Greek price

²⁰ In 2008, Greece's debt-to-GDP ratio was 117 percent. It rose to 171 percent in 2012 and then increased slightly to 175 percent in 2014 (Federal Reserve Bank of St. Louis FRED database).

²¹ "Greece benefits from an average loan maturity of over 30 years. The country pays neither interest nor redemption on the overwhelming part of its EFSF loans until 2023" (Credit Suisse 2015).

²² David Hume ([1742] 1955) described the equilibrating mechanism for the balance of payments known as the price-specie-flow mechanism in a gold standard.

Figure 5 Germany-Greece: Real Final Sales to Domestic Purchasers



Notes: Real final sales to domestic purchasers expressed as four-quarter percentage change. Real final sales to domestic purchasers is real GDP minus the change in inventories minus net exports. Heavy tick marks indicate fourth quarter of year.

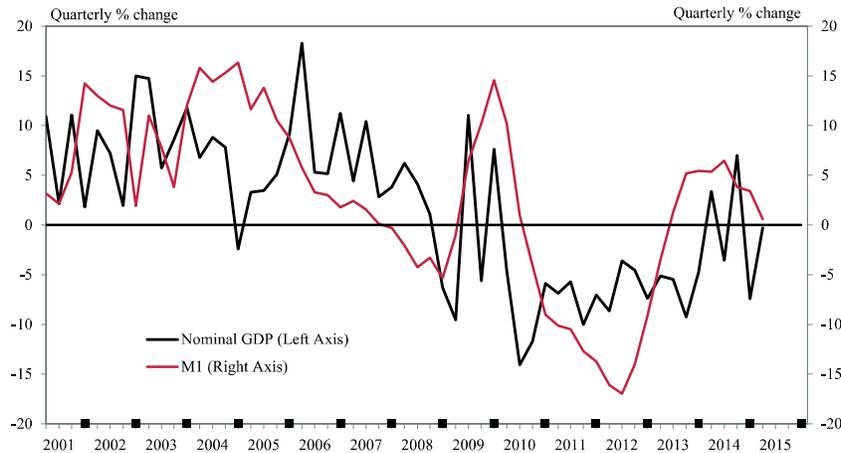
Source: Haver Analytics.

level has fallen sufficiently (the Greek terms of trade have depreciated sufficiently) in order to generate the required current account surplus.

The problem is that the price level does not adjust in a frictionless manner. There is the inherent disruption to production in forcing an unanticipated price-level reduction, which disturbs all relative prices. Those relative prices convey the information required to allocate resources. As shown in Figure 5, Greece and Germany both experienced recession with cycle troughs in 2009. Both recovered, but the recovery in Greece aborted in 2010 with the return to monetary contraction shown in Figure 6, related to the capital flight discussed above. Figure 6 shows for Greece the relationship between growth in money (M1) and in nominal GDP.²³ Broadly, the two series move together.

Figure 6 raises the issue of simultaneity. Because the ECB operates with an interest rate instrument, nominal GDP could determine the

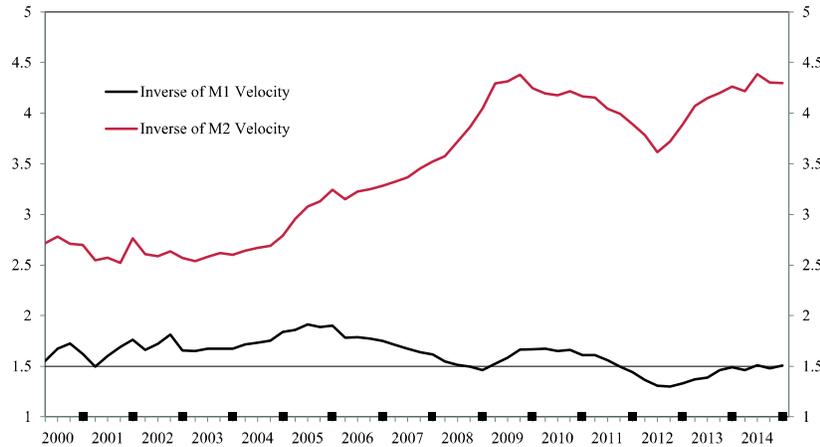
²³ In the absence of data on currency, M1 is sight deposits at Greek banks.

Figure 6 Greece: M1 and Nominal GDP

Notes: Quarterly percentage changes in M1 and nominal GDP. Heavy tick marks indicate fourth quarter of year.

Source: Hellenic Statistical Authority (ELSTAT)/Haver Analytics.

behavior of M1 within the Eurozone. Because Greece is only a small part of Eurozone GDP, Greek citizens can control their net exports in order to adjust their money holdings to nominal GDP. Figure 7 shows real money holdings for Greece—the ratio of M1 and M2 to nominal GDP or the inverse of velocity. What evidence is there that the relative stability in the M1 series reflects adjustment of nominal GDP (euro expenditure) to M1 holdings? Consider both series in Figure 7, which show real money demand expressed as the inverse of velocity, that is, the ratio of money to nominal GDP.

Figure 7 Greece: Inverse of Velocity

Notes: Quarterly observations of the inverse of M1 and M2 velocity. M1 velocity is nominal GDP divided by M1. M1 excludes currency in circulation. M2 velocity is nominal GDP divided by M2. Heavy tick marks indicate fourth quarter of year.

Source: Bank of Greece/Haver Analytics.

The monetary aggregate M2 includes significant amounts of long-term debt.²⁴ The increase in real M2 over the interval 2005 to 2008 reflects the external flows of funds into Greek bank debt given the optimistic environment of the time. The deceleration in M1 shown in Figure 6 then may reflect substitution out of liquid demand deposits into less-liquid debt instruments. The increased growth in M1 in 2009 likely reflects the reverse, a flight to liquidity. However, the strong deceleration in M1 over 2010 to 2012 is most easily explained by the capital flight prompted by fear that Greece would leave the Eurozone. Over this period, negative M1 growth is evidence of contractionary monetary policy.

²⁴ M1 comprises currency in circulation and overnight deposits. M2 comprises M1 plus deposits with an agreed maturity of up to two years and deposits redeemable at notice of up to three months.

It seems likely that the transmission of the monetary shock to the real economy occurred to a significant extent through financial frictions. The reduction in bank reserves associated with the sudden stop in capital inflows caused banks to restrict credit.²⁵ As a result, households and firms had to restrict expenditures. Exporters could not get the trade credit they require in order to export. Also, when capital flows in and finances a current account deficit, the price of assets like land rises. The fall in asset prices that accompanies a reversal of capital inflows disrupts financial intermediation when those assets serve as collateral. The essential monetary phenomenon remains, however, that a depreciation of Greece's intra-Eurozone terms of trade requires deflation.

The debt-deflation trap that Irving Fisher talked about in the 1930s applies to Greece. Fisher pointed out that deflation not anticipated at the time the parties entered into the debt contract leaves debtors with unexpectedly high debt burdens. The deflation that Greece must endure in order to generate the current account surpluses required to pay off its external debt raises the real burden imposed by euro-denominated debt. In a world of frictionless renegotiation of debt contracts, some combination of personal bankruptcy and restructuring would occur and economic activity would continue. However, in any country and especially in Greece with a poorly functioning judicial system, debt default is disruptive. Households and firms do not receive the credit they need in order to deal with disruptions to their cash flow and to make productive investments.

In a country like Greece where markets are highly cartelized, deflation is all the more disruptive and occurs only with recession and high levels of unemployment. The recession increases debt in a number of ways. First, it can permanently lower the productive capability of the economy.²⁶ Second, as output falls, tax revenue falls and the government deficit increases. Third, if households and firms default on their loans from banks, banks need recapitalization, further increasing

²⁵ The reserves of Greek banks rose after August 2007 in line with other Eurozone banks. The interbank market for reserves shrank as banks became concerned about lending to other banks whose portfolios could include U.S. subprime securities. The ECB replaced the market through full allotment of MRO lending that increased bank reserves to a level that limited the need for interbank borrowing. The reserves held by Greek banks fell sharply after July 2012 when ECB president Mario Draghi said that the ECB would do "whatever it takes" in order to prevent capital flight from the peripheral countries from breaking up the Eurozone.

²⁶ "The trauma of recession has been so harsh as to force people and companies, particularly skilled people and good, profitable companies, to leave Greece and set up operation elsewhere" (Congdon 2013, 5).

the government deficit.²⁷ In order to render tolerable the suffering of the Greek people and prevent complete economic collapse, the “institutions” (the Troika) extend additional loans to Greece. In order to achieve repayment, the addition to the debt burden then requires even more deflation. In 2005, Greece’s debt-to-GDP ratio was 98.6 percent, which rose modestly to 105.4 percent in 2008. However, during the depression it increased sharply to an estimated 174.9 percent in 2014.

As a matter of arithmetic, the debt-to-GDP ratio (D_t) equals the product of the prior period’s ratio (D_{t-1}) times the ratio of one plus the interest rate on the debt to one plus the growth rate of GDP minus the primary budget balance relative to GDP (PB):

$$D_t = D_{t-1} \left(\frac{1 + i_t}{1 + y_t} \right) - PB. \quad (1)$$

Debt sustainability is a requirement of an IMF assistance program. That is, given its program, the IMF must forecast a declining value of D in (1). As part of the two adjustment programs, it did so based in part on a forecast of positive future nominal GDP (y) growth. Specifically, it forecast a return to positive real GDP growth in 2012 combined with continued positive inflation, apart from price stability in 2011 (International Monetary Fund 2013b, 13). In fact, the growth rate of nominal GDP became negative in 2008:Q2 and remained negative through 2013. Instead of turning positive in 2012, real GDP growth was near -6 percent in 2012. It seems likely that additional aid to Greece will require the politically difficult decision by the Eurozone countries to lend more while also forgiving existing debt, perhaps through lengthening the maturity of repayment.

5. WHY DEFLATION IS NOT OVER

Official IMF forecasts have regularly fallen short in their estimation of the time that would be required for Greece to emerge from recession and exit its bailout programs. One possible reason for the unwarranted optimism was the limited experience of the IMF in dealing with crises in a monetary union. Pisani-Ferry, Sapier, and Wolff (2013, 10–1) noted that the majority of past IMF programs “were accompanied by a sharp currency depreciation.” Among countries with fixed exchange

²⁷ “The payment culture has been weakened, including through repeated moratoria on auctioning foreclosed assets. And the insolvency framework has been unable to deal with either the rehabilitation of viable entities or the liquidation of non-viable entities...[R]esources remain trapped in unproductive or inefficient activities...Greece has one of the highest levels of NPLs [nonperforming loans] globally” (International Monetary Fund 2014, 15).

rates that received IMF bailouts, almost all had capital controls. In contrast, until July 2015, Greece had “irrevocably fixed exchange rates and a regime of unfettered capital flows.” That is, the terms of trade adjustment had to occur through deflation rather than depreciation of the currency.

Using measures of the real effective exchange rate (REER) for countries in the Asian and Latin American crises, Pisani-Ferry, Sapier, and Wolff (2013, 10–1) calculated the currency depreciation that occurred during the crises.²⁸ For the Latin American countries, the depreciation amounted to about 40 percent. For the Asian countries, the initial depreciation was about 40 percent but then settled down at 30 percent. Comparison with the Asian and Latin American experiences suggests that Greece could need an even larger depreciation in its terms of trade. These countries went into the crisis with current account deficits not far from 5 percent. Greece went into the crisis with a current account deficit of 15 percent.²⁹

A number of factors apart from those mentioned in the previous section exacerbate the internal deflation required by Greece. First, after the crisis, the Greek terms of trade appreciated. Figure 8 shows German and Greek inflation. Greek inflation actually increased after the crisis. The increase in excise taxes and the value-added tax required by the terms of the 2010 bailout pushed up prices with the effect of increasing the ultimate required deflation. Moreover, as shown in Figure 8, the disinflation in the Eurozone, which appears in declining German inflation, implies that in order to depreciate its terms of trade Greece must deflate.³⁰

Second, the adjustment is more severe if the country starts with significant external debt. Payment of the interest and principal on the debt then necessitates running current account surpluses beyond simply eliminating the deficit. Toward the end of 2013, the ratio of external debt to GDP was about 100 percent in Greece (Goldman Sachs 2013, 3). Third, the smaller the tradeable goods sector relative to the nontradeable goods sector, the more difficult it is to expand exports. In

²⁸ The REER is calculated as a trade weighted-average of the exchange rates of the country with its trading partners adjusted by the consumer price indices (CPIs) of the country and its trading partners. The Asian crisis countries, with crisis dates in parentheses, were Indonesia (1997), Korea (1997), Thailand (1997), and the Philippines (1998). The Latin American countries were Brazil (1998), Argentina (2000), and Uruguay (2002).

²⁹ In the May 2010 assistance program for Greece, the Troika estimated the “need of a real exchange-rate depreciation...of the order of 20–30 percent” (Pisani-Ferry, Sapier, and Wolff 2013, 67).

³⁰ Since 2009, core CPI inflation for the Eurozone has fallen short of 2 percent. In May 2015, year-over-year core CPI Eurozone inflation was .9 percent.

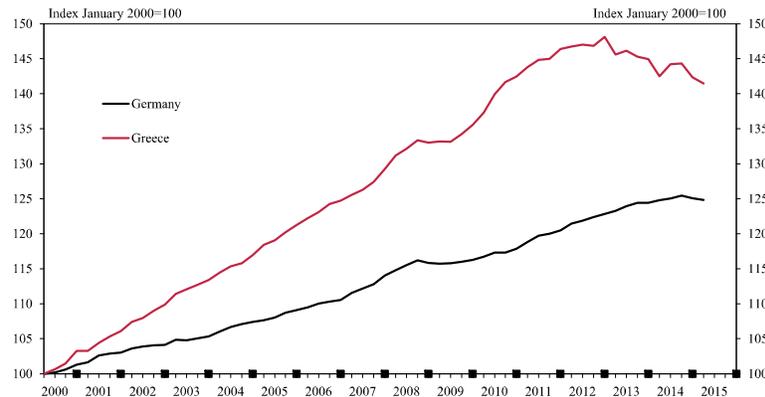
Figure 8 Germany-Greece: Inflation

Notes: Inflation is the harmonized CPI. Monthly observations of 12-month percentage changes. Heavy tick marks indicate December.

Source: Haver Analytics.

Greece, the tradeable goods and services sector is just above 30 percent. In Ireland, in contrast, it is near 50 percent (Goldman Sachs 2013, 6). Although by the end of 2012, Greece had come close to current account balance, much of the improvement came from the effects of severe recession in depressing imports (Figure 4). That fact suggests that the deflation required in order to achieve a sustained surplus in the current account has only just begun. Because imports will increase as the economy recovers, it seems likely that Greece must deflate further in order to achieve an internal Eurozone terms of trade consistent with full employment.

Between 2000:Q1 and 2014:Q3, the Greek terms of trade appreciated relative to Germany's terms of trade in that the Greek CPI rose 45 percent and the German CPI rose 25 percent (Figure 9). If the appreciation in the Greek terms of trade that occurred in the first decade of the Eurozone was due solely to a capital inflow that will not return, Greek deflation will have to undo the prior inflation difference between it and its Eurozone partners. Since 2012, with some Greek deflation,

Figure 9 Germany-Greece: Inflation Divergence

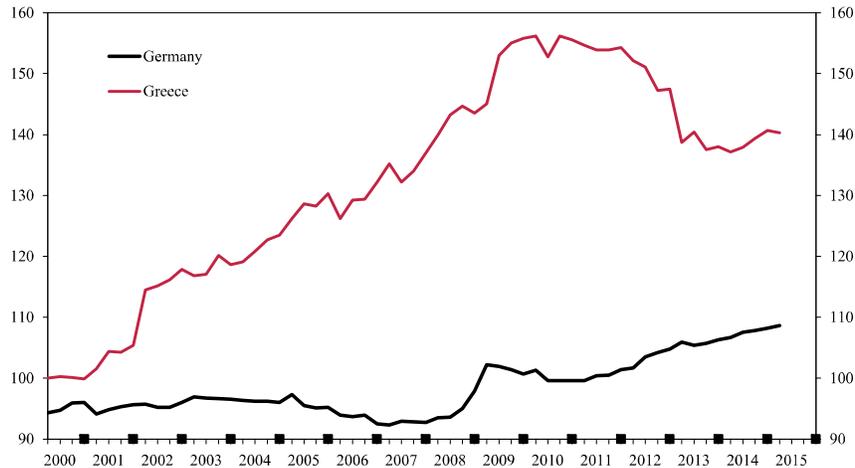
Notes: Consumer prices indexed to January 2000=100. Heavy tick marks indicate fourth quarter of year.

Source: EuroStat and Haver Analytics.

the Greek terms of trade have depreciated but only a little. Moreover, because other peripheral countries like Spain and Ireland have become more competitive, Greece may have to undergo an even more prolonged deflation in order to restore external trade balance.

Figure 10 tells a similar story in terms of the divergence in unit labor costs. The Greek/German difference widened through 2009 but narrowed subsequently.³¹ The comparison with Germany rather than with other Eurozone countries does understate the progress Greece has made. Calculation of the real effective exchange rate while showing only moderate depreciation based on the CPI shows significant improvement based on unit labor costs (International Monetary Fund 2013b, 37). (An offsetting factor is that reducing the Greek unemployment rate of 26 percent and a youth unemployment rate of 49 percent

³¹ The May 2010 IMF program had an objective of eliminating a “20–30 percent competitiveness gap...through wage adjustment and productivity gains” (International Monetary Fund 2013b, 1). Without recourse to a depreciation of its currency, Greece had to achieve the required reduction in unit labor costs through some combination of domestic deflation and productivity increases.

Figure 10 Germany-Greece: Nominal Unit Labor Costs

Notes: Quarterly data. Heavy tick marks indicate fourth quarter of year.

Source: EuroStat and Haver Analytics.

will draw additional workers into the labor force with lower productivity and will likely increase unit labor costs.) As the Eurozone recovery gains momentum, the reduction in its unit labor costs should benefit Greece's exports. The key issue then is whether dysfunction in the Greek banking system will limit exports by restricting the access of Greek exporters to credit.³²

In order to free the resources required for an excess of exports over imports at full employment, Greece must achieve an internal as well as an external terms-of-trade depreciation. First, in order to channel domestic production into exports, Greek unit labor costs will likely have to decline further. Without increases in productivity, real wages must fall through a greater decline in nominal wages than in prices.

³² In Ireland, Spain, and Portugal, the return to current account balance by 2015 has come in significant part from an increase in exports (Wolff 2015a). The contrast with Greece likely reflects in part the better functioning of these countries banking systems.

Second, in order to draw resources into the export sector, the price of nontradeable goods must decline relative to the price of tradeable goods. According to the International Monetary Fund (2013b, 37), Greece has not progressed in this respect: “Despite reform attempts, professions like pharmacology and law, as well as the transport and energy sectors, remained closed to new entrants. Continuing protection caused prices of nontradeables to remain elevated relative to the prices of tradeables. . . .”

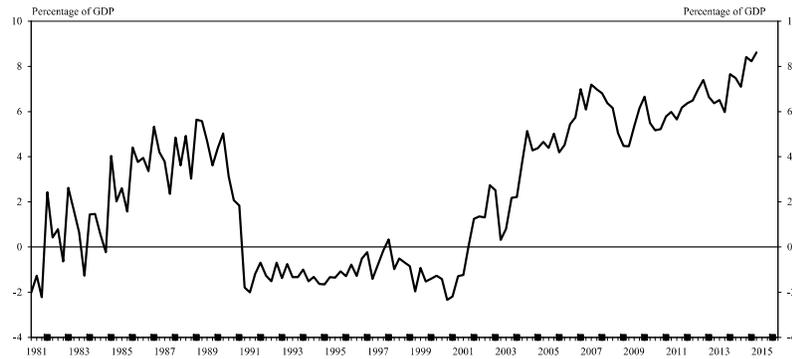
6. IS GERMANY A GOOD MODEL FOR GREECE?

When the Eurozone began operation, Germany was in some respects in the position in which Greece finds itself in 2015. Germany entered the Eurozone in 1999 with an exchange rate that overvalued its goods and services. As a consequence, after its entry into the Eurozone in 1999, it had to experience low inflation and high unemployment. Prior to its entry, in the context of instability in the European exchange rate mechanism, capital inflows into Germany had appreciated the German mark, traditionally the strongest currency in Europe. The other reason for the overvaluation of the mark at the creation of the Eurozone went back to German reunification.

As shown in Figure 11, Germany normally runs a current account surplus. That is, it is a net capital exporter. After the fall of the Berlin Wall and reunification of East and West Germany, the requirements of infrastructure investment in East Germany meant that Germany needed for a while to change from a capital exporter into a capital importer (Hetzel 2002). In order to provide the additional resources needed in Germany, Germans had to buy more from foreigners, who in turn had to buy less from Germans. This reversal required that prices in Germany had to rise more than the prices of its trading partners. Germany’s terms of trade had to appreciate.

Germany’s current account deficit became moderately negative from 1990 through 2001. Thereafter, it rose steadily and stabilized at around 7 percent of GDP. Figure 12 breaks the current account deficit into exports and imports. Germany’s success as an exporter appears in the increase in its exports as a percentage of GDP from around 27 percent in the 1980s to more than 45 percent at present. One reason for that success was that German labor unions were willing to hold down wage growth in order to limit the movement of manufacturing jobs to the formerly communist Eastern European countries.³³ As a result, unit

³³ “Germany established its own new lower norm of zero nominal unit labor cost inflation resulting from a consensus between the trade unions, workers’ representatives

Figure 11 Germany: Current Account Balance

Notes: Current account expressed as a percentage of nominal GDP. Data prior to 1991 are for West Germany. Heavy tick marks indicate fourth quarter of year.

Source: Deutsche Bundesbank and Haver Analytics.

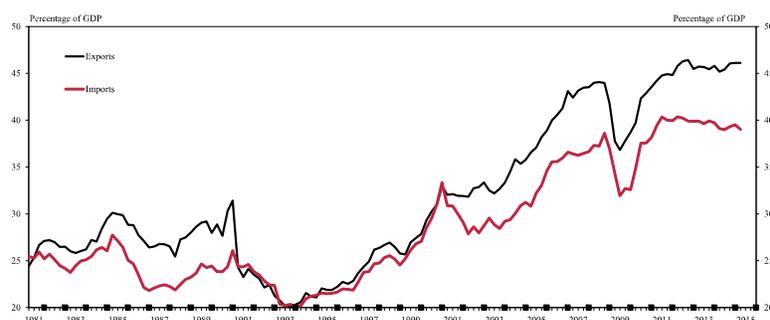
labor costs hardly moved. Also, in 2003, German Chancellor Gerhard Schröder introduced extensive labor market reforms (the Hartz reforms or Agenda 2010).³⁴

At the same time, international events, especially, growth in the Chinese economy, created a demand for the specialized exports of Germany such as machine tools. Along with the restructuring of the German economy, the result was a boom in German exports to the rest of the world. An increase in the current account surplus powered growth in the German economy.³⁵ Export growth came especially from the

and employers that wage restraint was pivotal to preserve Germany's competitiveness, reduce unemployment and prevent further relocation of labor to Eastern Europe and other low-wage countries" (Lin and Treichel 2012, 12).

³⁴ Germans felt that they had put into place difficult reforms. The *Financial Times* (2013) cited Professor Falter, professor of politics at Mainz University: "It is like the La Fontaine fable of the ant and the grasshopper. German voters are convinced that they have tightened their belts as a result of Agenda 2010....And like the ant in the La Fontaine fable, they do not see why they should pay again to bail out the spendthrift grasshoppers."

³⁵ While Germany's trade balance with other Eurozone countries fell from €37 billion in 2007:Q4 to €18 billion in 2014:Q4, it rose with non-Eurozone countries from €4 billion to €27 billion. As a percent of GDP, Germany's exports rose from 28 percent in 2000:Q1 to 48 percent in 2014:Q4 (Haver Analytics).

Figure 12 Germany: International Trade

Notes: German exports and imports expressed as a percentage of nominal GDP. Heavy tick marks indicate fourth quarter of year.

Source: Eurostat and Haver Analytics.

export of capital goods, which account for 9 percent of German GDP, to emerging markets.³⁶ It seems likely that if Germany had retained the mark, the mark exchange rate with its trading partners would have appreciated more than the euro appreciated in the first decade of the 2000s.

Can the German model of structural adjustment in the first half of the early 2000s carry over to Greece? Two factors suggest a negative answer. First, until 2009, core inflation in the Eurozone remained near 2 percent. As a result, depreciation of the terms of trade for Germany could occur with low (less than 2 percent) but still positive inflation. As noted above, the subsequent low inflation rate in the Eurozone has meant that Greek adjustment requires deflation. Second, Greece has not benefited either from a strong world economy or from growing world demand for its exports. For example, Turkish beaches have become strong competitors for Greek beaches. Most important, Germany never had to deal with capital flight.

³⁶ As reported in the Deutsche Bank Weekender newsletter (2014), all of the 3.5 percent growth in the Eurozone since the 2009 cyclical trough through mid-2014 came from net exports with two-thirds of the increase in the goods trade balance coming from emerging markets in which Germany had an advantage.

7. IS ABANDONING THE EURO A PRACTICABLE SOLUTION FOR GREECE?

The assumption here is that the euro is so thoroughly embedded in Greek society that the reintroduction of the drachma combined with a floating exchange rate would not eliminate the need for continued Greek deflation. The reason is that the Greeks would continue to use the euro rather than the drachma for money.³⁷

Money serves three functions. It is a medium of exchange, a store of value, and a unit of account. Reintroduction of the drachma even with its required use for the payment of taxes and in government transactions would not necessarily entail its replacement of the euro for these functions. The reintroduction of the drachma would most surely be accompanied by the expectation that it would depreciate—an expectation likely to be self-fulfilling. Greeks would continue to rely on the euro for money.

In principle, the Greek government could reintroduce the drachma with the commitment to maintain internal price stability. With the passage of years, perseverance could make the commitment credible, and Greek citizens would again use the drachma for all three functions of money. In the interval, however, the euro would continue as the medium of exchange for high-value transactions, as a store of value, and as the unit of account. The depreciation of the terms of trade required for external stability would require the same deflation in the euro prices that Greeks would continue to assign to their goods as is currently required with the euro as the national currency.

The conclusion is that Greece will need to continue with deflation. However, the uncertain pace and amount of the deflation means that it cannot be anticipated in a way that is built into forward-looking price setting and into euro contracts. Consequently, it will continue to depress economic activity. A relaxation of austerity, which might lessen the distress caused by the depression, is unlikely. Greece has had to impose fiscal austerity in order to run a primary fiscal surplus (a surplus before interest payments on debt). It has had no choice but to run a primary surplus. Otherwise, investors would question whether the government would ever raise the revenue to repay its debt. At 1.2 percent of GDP in 2014, the primary balance (excluding

³⁷ From 1991 until 2002, Argentina operated a currency board. That is, it converted dollars and pesos at a one-for-one ratio while allowing the change in pesos to pass directly through to the peso monetary base. Because the pesos continued to circulate as currency, for Argentina, which suffered deflation under its currency board, the option existed of abandoning the currency board and depreciating the peso. Unfortunately for Greece, the fact that unlike the peso the drachma disappeared makes the case of Argentina inapplicable.

one-time adjustments) offers a minimal margin for increasing government expenditure (Darvas 2015, Annex). Structural reform can lessen the need for depreciation in the Greek terms of trade and thus for deflation. The following section offers some comments on why structural reform is so difficult.

8. THE DIFFICULTY OF STRUCTURAL REFORM

George Bitros (2013, 26), professor emeritus at Athens University of Economics and Business, argued that “the public budget became the spoils of politicians, tightly organized minorities and interlocking groups of business interests” and that the movement away from a free-market economy to an economy organized around monopolies and government regulation occurred “mainly because of the sharp partisan competition that emerged in the political arena” after the ousting of the military government in 1974. The impression left by Bitros is that, given the weakness of Greek institutions, politicians found it costly to form the coalitions required to hold power. Given the weakness of the state in raising tax revenues, political parties thus found it expedient to encourage the formation of cartels. These cartels, which are protected from competition, receive rents (monopoly returns) in return for government-enforced restrictions on entry. Effectively, a monopoly can impose and collect a tax that does not appear on the government’s books.

Hayashi, Li, and Wang (2015, 1) summarized the stylized facts surrounding the innovation that leads to new industries. “As new industries evolve from birth to maturity, it is typically observed that price falls, output rises, and firm numbers initially rise and later fall.” Researchers term the decline in firm numbers “shakeout.” The lesson is that the innovation spurred by competition requires free entry and free exit. The highly regulated Greek economy discourages both.

Slok (2012) reported the World Bank ranking of countries according to ease of doing business. In 2013, Greece ranked 78 overall but ranked even lower in key categories. For example, in the category “starting a business,” which measures factors such as days required in order to obtain a license, Greece ranked 146. In registering property, it ranked 150, and in enforcing contracts it ranked 87. As a condition for Troika assistance, Greece passed laws liberalizing entry into markets and professions but then delayed their implementation (International Monetary Fund 2013b, 18). In Greece, there are more than 500 regulated professions accounting for about one-third of employment (International Monetary Fund 2013a, 15). Similarly, Greece has moved only slowly to eliminate employment protection laws. The International Monetary

Fund (2014, 23) noted with respect to the law that limits collective dismissals, “[N]o such dismissal has been approved for thirty years. . . .” Heavy government regulation along with the arbitrary application of laws encourages corruption (Cambanis 2014).

Still, a balanced view must recognize that over the years 2010 to 2014, Greece did make significant progress in reforming its government and economy. Among the countries receiving bailout support from the countries of the Eurozone, Greece’s fiscal restructuring was the most rigorous. Zsolt Darvas (2015, Table 1) calculated the structural primary balance for Greece excluding one-off receipts and payments such as the cost of recapitalizing the banking system. Thus, his figures not only account for one-time adjustments but also for cyclical influences, which increase the deficit, and for payments on debt. For Greece, the structural primary balance went from -10.0 percent of GDP in 2009 to 6.1 percent of GDP in 2014.

A key demand of Greece’s creditors has been for pension reform. Greece has made significant cuts in its pension payments both present and promised (Gupta 2012). Because Greece has not had a significant private pension system, pensioners depend upon government pensions and many now live in or near poverty. At the same time, Greek demographics render the government pension system insolvent over the long run. Greece’s spending on pensions as a percent of GDP at 17.5 percent in 2012 is the highest in Europe. Moreover, only 36 percent of Greeks aged 55–64 work compared to 63 percent in Germany (*The Economist* 2015). Long-term demographics are unfavorable. “More than one in five Greeks is older than 65, making it the world’s fifth oldest nation. Just 14 percent is under 15, a smaller share of youngsters entering the labor force than all but nine other countries” (Goldenberg 2015).

9. WHERE TO GO FROM HERE

Unfortunately, dialogue between Greece and its creditors about the way forward is difficult because of the divergence of views about the causes of the Greek depression. A “creditor” view often associated with Germany is that fiscal indiscipline in Greece led to an unsustainable level of debt. The collapse of the stimulus to demand provided by this level of debt led to the depression. A related “German” view is that the long-term viability of the Eurozone depends upon adherence to rules. Rules enforcing fiscal discipline prevent the Eurozone from becoming a transfer union in which the more fiscally responsible members bail out the less fiscally responsible members. From this perspective, it is essential that Greece run a primary surplus sufficient to repay the loans from other Eurozone members. The debate is intensified by criticism

that Greece broke the rules of the Maastricht Treaty requiring fiscal discipline. For example, Jose Manuel Barroso, the former president of the European Commission, argued (European Commission, 2013):³⁸

We have a Stability and Growth Pact. We have rules...so these unemployed people in Greece should be told that the authorities of their country did not respect the Treaties that they have signed....[T]he biggest lesson of the crisis...is that growth based on debt is not sustainable.

More succinctly, *The Wall Street Journal* (2013) wrote:

[C]reating a rigid “Europe of Rules” is exactly the German-led strategy for managing the crisis. Berlin’s aim is to perfect the monetary union by ensuring countries adhere to rules designed to prevent future crises by addressing what are seen as the causes of the current one: government overspending and excessive risk-taking by banks.

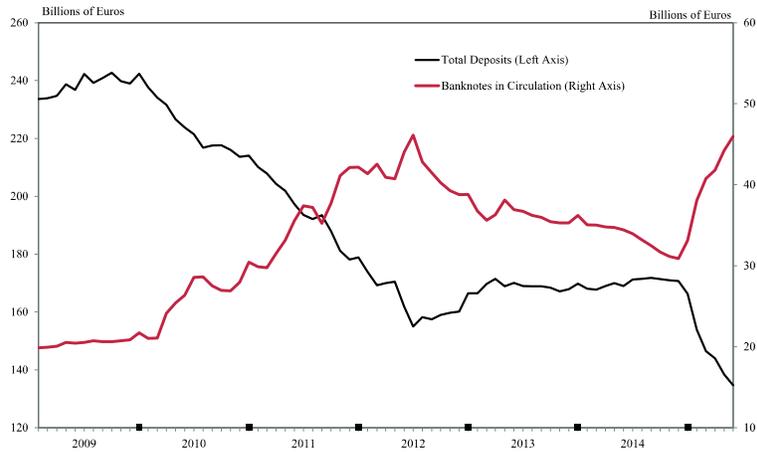
A contrasting view common in Greece is that its recession is due to the fiscal consolidation required by its official creditors. Based on an interview, Hansen (2015, 36, 38, 52) offered insights into the views of former Greek Finance Minister Yanis Varoufakis:

Varoufakis has staked his academic integrity on a particular economic and moral critique of the crisis....Greece, he said, would no longer simply acquiesce to the austerity doctrine of the European Commission, the European Central Bank and the I.M.F....Varoufakis...wanted to show the Europeans how to save Europe itself....Varoufakis traces his political consciousness to his childhood in “the junta era”....“I am not going to fold on pensions” or on restoring collective bargaining rights.

Moreover, many members of Syriza are committed socialists who are opposed to free market reforms and privatization on principle. They do not see a free-market economy as allocating resources to their most productive use but rather as a license for the powerful to exploit the weak. Upon taking power, the Syriza government indicated a desire to undo the labor market reforms agreed to under the previous two adjustment programs such as lowering the minimum wage, weakening collective bargaining requirements, and limiting the prohibition of collective dismissals. No doubt for this reason, the text of the Euro

³⁸ Critics of the German policy of austerity have pointed out that Germany broke the rules of the Maastricht Treaty when it ran a deficit of 4 percent of GDP in 2004 with a debt-to-GDP ratio of almost 65 percent. However, Germany never had to worry about capital flight.

Figure 13 Greece: Total Deposits and Banknotes in Circulation



Notes: Heavy tick marks indicate December. Data are from Bank of Greece. Deposits are from Aggregated Balance Sheet of Monetary Financial Institutions. Banknotes in circulation are from Bank of Greece Financial Statement. The series is “Banknotes in circulation,” which is based on a formula, plus “Net liabilities related to the allocation of euro banknotes within the Eurosystem,” which is based on the additional issuance of banknotes.

Source: Bank of Greece and Bloomberg.

Summit statement on Greece of July 13, 2015, required Greece to comply with detailed reforms in its product and labor markets.

The standoff between Greece and its creditors came to a head on July 12, 2015. The imminent collapse of the Greek banking system forced Greece into accepting the demands of its creditors. From January 2010 through June 2012, deposits flowed out of Greek banks. From July 2012 through November 2014, their deposits stabilized. Starting in December 2014, however, with the political uncertainty created by Syriza coming to power, significant outflows of deposits resumed (Figure 13).

In this situation, the ECB became the key player. The Greek government had avoided the imposition of capital controls only because

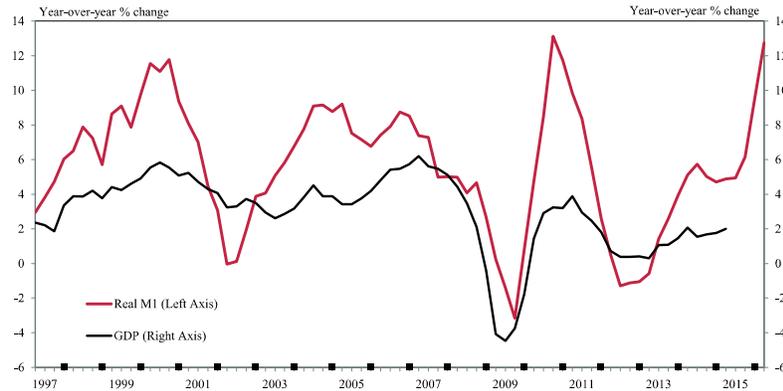
the ECB had regularly raised the cap on ELA lending by the Bank of Greece in order to finance the outflows of deposits from Greek banks. Doing so required the ECB Governing Council every two weeks to certify the solvency of the four large Greek banks that the ECB supervises. However, in the absence of an agreement between Greece and its creditors, the ECB was in a difficult situation. As the single regulator for the large banks of the Eurozone, it had to worry about its credibility for certifying the health of banks. Moreover, in the event of a default by the Greek government on its debt, it would have trouble using Greek government debt to collateralize its lending to Greek banks. As a central bank, the ECB is constrained by the central bank principle of lending only on good collateral.

At the end of June, Greek Prime Minister Alexis Tsipras interrupted negotiations with Greece's creditors in order to hold a referendum on July 5 on their proposal. Greece's EFSF assistance program expired at the end of June and it failed to make a payment owed to the IMF. Outflows of deposits from Greek banks then surged. When the ECB declined to raise the ELA limit further, the Greek government imposed capital controls on banks. Greek depositors could only withdraw a limited amount of cash each day from banks and they could not transfer funds out of the country. Lacking the ability to transfer funds abroad, importers could not import. Exporters also suffered from not being able to import raw materials. The possibility that the ECB would close Greek banks by ending ELA lending broke the impasse and started negotiations for a third adjustment program on terms set by the IMF and the European Commission representing the finance ministers of the Eurozone.

10. A REASON FOR HOPE

It is not realistic to believe that Greece can leave the Eurozone. Even though Greece had its own printing presses before the introduction of the euro, the paper for printing the bills has to be ordered from abroad. It takes time to print money and distribute it among banks. In the time required to plan for the reintroduction of the drachma, depositors in Greek banks will have fled. More fundamentally, money is a public good in the sense that its value comes from its universal acceptance. Only over a long period of fiscal discipline could the Greek government persuade its public to hold drachmas instead of euros as a store of value.

The reality then is that Greece will likely have to continue deflation for many years. In the near term, the increase in the value added tax to a uniform 23 percent is an exogenous cost-push shock that will

Figure 14 Euro Area: GDP and Real M1 Growth Rate

Notes: Quarterly observations of four-quarter percentage changes in real M1. Real M1 lagged by four quarters. Real M1 is M1 divided by the CPI. Heavy tick marks indicate fourth quarter of year.

Source: M1 data from 1996 to 2012 are from the Bundesbank and M1 data from 2012 to 2015 are from Haver Analytics.

exacerbate inflation and further depress the Greek economy. However, Greece can mitigate the need for deflation through policies that encourage voluntary capital inflows. Remaining in the Eurozone will limit the need for terms of trade depreciation by encouraging external investment. A national commitment to deregulate markets in order to allow free entry and exit would also promote investment from abroad. In addition, free-market reforms would lessen the need for terms-of-trade depreciation through deflation by creating a more competitive export sector.

There are reasons for optimism about the Eurozone economy. The ECB's policy of quantitative easing will encourage continued recovery and, if sustained, return inflation to the 2 percent target. As shown in Figure 14, which plots real GDP and real M1 lagged four quarters, strong money growth presages a vigorous economic recovery (Ireland and Oracic 2015). A strong Eurozone recovery will encourage the demand for Greek exports and lessen the need for deflation. Moreover,

Spain has reformed its labor markets to a significant degree and Ireland has retained an open economy. Both are experiencing strong export growth and strong economic recoveries. It is possible that their example will encourage a similar national consensus for reform in Greece.

Figure 13 shows Greek bank deposits and banknotes in circulation. It offers a sensitive barometer of confidence in Greece and its economy. The fact that deposits declined from 2010 to mid-2012 and then only slowly recovered indicates the length of time required in order to rebuild trust in the banking system. Now that Greece has imposed capital controls, depositors will be quick to withdraw deposits at any sign of financial stress. Reopening a recapitalized Greek banking system with growth in deposits and in lending will be a key measure of whether Greece can again restore growth. For that to happen, the ECB will have to commit to maintaining liquidity for Greek banks and Greece will have to commit to structural reform.

In significant ways, Greece was dealt a bad hand. Its problems would have very likely been manageable without the double-dip recession in the Eurozone (Hetzel 2013). However, it has also played poorly the hand it was dealt. In the 1990s in the run up to Greece's admission into the Eurozone, Greece engaged in a national conversation about the need for fiscal discipline and the structural reform required in order to become a viable member of the Eurozone. Once admitted to the Eurozone, however, it backed away from these commitments. Now, as part of renewed negotiations over reform combined with continued aid and debt relief, Greece must revive this conversation and decide where its future lies.

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